Proceedings of the

1st International Solar Expo and Conference - ISE

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Preamble

I am pleased to write this Preamble for the Proceeding Book of the First International Solar Expo and Conference. Indeed, this is high time to launch a dialogue among the key players of the expanding solar industry in the country. This Event has provided such an interactive forum where avenues could be explored how to apply the existing knowledge in overcoming the energy crises, environmental threats and raising levels of unemployment.

Our journey commenced with the graduation in Electrical Engineering, of the founders of GreenWend Energy Private Limited Peshawar, Engr Zeeshan Saeed Shah, Engr Samia Subhan Qureshi and Engr Saad Rashid from the University of Engineering and Technology (UET), Peshawar. They got Masters from USPCAS-E and were part of the last cohort of USPCAS-E exchange scholars to visit the U.S. They continued research work at the Photovoltaic Reliability Laboratory of Arizona State University (PRL-ASU).

Engr Samia was described as a startup founder by the Arizona State University, USA (Sano 2019). When asked to describe the importance of her research, she suggested that by eliminating the use of pyranometers, pyrheliometers and two-axis trackers for an outdoor angle of incidence (AOI) measurement, their proposed model offers a cost-effective outdoor AOI measurement. She helped Engr Zeeshan, her husband, in conceptualising and establishing GreenWend Company as a private company. Her success story was presented at a high-level meeting between the Government of Khyber Pakhtunkhwa and USAID, chaired by Mr Donald Blome, the U.S. Ambassador to Pakistan on April 11, 2022.

Engr Zeeshan, after graduating from UET Peshawar, desired to establish his own business setup rather than joining some government organisation for a job, as per practice of the youth in the country. He went through prolonged consultation and feasibility studies and joined a local company for evaluate the prevailing practices in the market. He invited his colleagues to establish a solar energy company for providing services to the residential and commercial clients. GreenWend Energy Pvt Ltd Peshawar was registered as a company under a partnership deed with GoKP, PEC and SECP.

R&D Team of GWE, headed by Engr Saad Rashid, designed an inverter, green energy metres and lithium ion batteries, produced in Chinese factories and marketed in various cities with the name SunSaviour. Technical cooperation with German and US Universities and Companies was established by Irfan ul Haq Qureshi, Strategic Planner GWE. Various commercial companies, Universities and R&D Organizations were engaged under the ISE2024 for interaction through stalls, panel discussions, and poster presentations.

We expect that ISE2024 will facilitate various stakeholders for interaction and find solutions for the issues they are facing. Policy Recommendation will be prepared for overcoming the energy crises, unemployment issues, environmental threats and the increasing import bills of the government.

Pakistan Zindabad.

Prof M Subhan Qureshi
Chief Patron ISE2024

Message of

Javed Iqbal Khattak

Chief Executive Officer

KPEZDMC

“Embracing Solar Power for a Sustainable Future” is our slogan for solar energy. We extend our warmest congratulations to the organisers of the first International Solar Expo and Conference in Peshawar. This landmark event signifies a crucial step forward in promoting solar energy adoption and fostering sustainable practices in Pakistan.

The participation of academia in this expo is commendable as it opens new avenues of learning, research, and collaboration. The exchange of knowledge and ideas between academia and industry will undoubtedly fuel innovation and drive progress in the solar energy sector.

Furthermore, we applaud the industry participants for showcasing their cutting-edge technologies and solutions at this expo. The opportunity to highlight advancements in solar technology, energy efficiency, and sustainability practices will inspire positive change and drive the adoption of solar energy across various sectors.

As we celebrate this momentous occasion, it is imperative to recognize the transformative potential of solar energy for our nation's industry and economy. At KPEZDMC, we are proud to be at the forefront of green energy solutions and advocates for the widespread adoption of solar power.

Our commitment is evident through initiatives such as the installation of solar panels in the Chitral Economic Zone, harnessing the region's solar resources for sustainable industrial development. Additionally, our upcoming KPEZDMC head office building, powered entirely by solar energy, exemplifies our dedication to sustainable practices. We are planning to convert our offices to green energy in other zones, further demonstrating our dedication to sustainable practices and reducing our carbon footprint.

The benefits of solar energy are vast and impactful. Not only does it reduce our carbon footprint and reliance on fossil fuels, but it also creates jobs, fosters innovation, and contributes to economic growth.

As we embark on this journey towards a greener and more sustainable future, let us collaborate, innovate, and invest in solar energy solutions. Together, we can unlock the immense potential of solar power and pave the way for a brighter tomorrow for Pakistan.

Congratulations once again to the organisers, GreenWend Energy, for successfully arranging this groundbreaking expo and conference. May it inspire meaningful discussions, collaborations, and actions towards a more sustainable and prosperous Pakistan.

Message of

Dr. Adnan Daud Khan

Director
USPCASE, UET Peshawar

As the Director of U.S.-Pakistan Center for Advanced Studies in Energy (USPCASE) at UET Peshawar, I am proud to see our city host such a pivotal event that brings together experts, researchers, industry leaders, and policymakers. This platform will certainly facilitate the exchange of innovative ideas, cutting-edge research, and practical solutions that can drive the solar energy sector forward.

ISE2024 provides an exceptional platform for knowledge exchange, collaboration, and showcasing cutting-edge technologies. The various keynote speeches, panel discussions, and exhibitions will indeed inspire new ideas and partnerships. I encourage all participants to take full advantage of these opportunities to learn, network, and contribute to the growth of the solar energy sector.

At USPCASE, we are committed to fostering an environment of academic excellence and industry collaboration. Our goal is to develop sustainable energy solutions that address the unique challenges of our region and beyond. This conference aligns perfectly with our mission to promote research, education, and innovation in renewable energy.

I would like to extend my heartfelt appreciation to the organising committee for their dedication and hard work to make this event a success. I am confident that the discussions and partnerships formed here will pave the way for significant advancements in solar energy.

Let us use this opportunity to inspire and be inspired, to innovate and to collaborate, and to collectively work towards a greener and more sustainable future.

Message of

Engr Zeeshan S Shah

Chief Executive Officer
SunSaviour Pakistan

It is with immense pride and gratitude that I address you through this proceedings book of the International Solar Expo 2024. The past two days have been a remarkable journey of discovery, innovation, and collaboration, reflecting the collective spirit and commitment of all those who participated in this groundbreaking event.

SunSaviour's vision for organising this expo was to create a dynamic platform that brings together students, entrepreneurs, industry professionals, and stakeholders from across the globe. Our mission was to foster a collaborative environment where innovative ideas could be shared, partnerships could be forged, and new opportunities could be explored. I am delighted to say that we have achieved these goals beyond our expectations.

The theme "Innovations for a Sustainable Future" resonated throughout the expo, highlighting the urgency of transitioning to clean and renewable energy sources. We witnessed an extraordinary array of innovative projects, from a cleaning robot designed to maintain solar panels to groundbreaking agricultural solutions integrating solar technology. These innovations are not just concepts; they are the future, and SunSaviour is committed to supporting their development and implementation.

One of the most gratifying aspects of the expo was the active participation of students and young innovators. Your enthusiasm, creativity, and dedication are the driving forces behind the future of renewable energy. The educational workshops, career opportunities, and innovation challenges you engaged in are invaluable steps toward a successful and impactful career in this critical field.

To the industry professionals and company representatives, I extend my deepest appreciation for your commitment to advancing solar technologies and sustainable practices. Your presence and contributions have enriched this expo, providing invaluable insights and forging new pathways for collaboration and growth. The panel discussions, policy dialogues, and networking sessions have laid the groundwork for future advancements and have significantly contributed to the solar industry's progress.

The International Solar Expo 2024 saw an unprecedented attendance of over 5000 participants. This overwhelming response is a testament to the importance of our cause and the collective desire to drive positive change. The new MOUs signed and the numerous opportunities explored during this event are clear indicators of the expo's success and its impact on the renewable energy landscape.

In closing, I would like to express my heartfelt gratitude to all the participants, volunteers, organisers, and partners who made this event possible. Your unwavering support and dedication have been instrumental in making the International Solar Expo 2024 a resounding success. Together, we have taken significant steps toward a sustainable and prosperous future.

Thank you for being part of this journey. Let us continue to innovate, collaborate, and strive for a world powered by clean and renewable energy.

Message of

Engr Irfan Ul Haq Qureshi

Coordinator General
ISE 2024

I am honored to welcome you to the International Solar Expo & Conference (ISE) 2024. This event marks a significant milestone in our collective efforts to promote and advance solar energy solutions. As the Coordinator General, it has been my privilege to work alongside a dedicated team of professionals, academics, and industry leaders to bring this event to fruition.

ISE 2024 is not just an exhibition; it is a celebration of innovation, collaboration, and the relentless pursuit of sustainable energy solutions. Our objectives align closely with the United Nations Sustainable Development Goals (SDGs), particularly SDG 7 (affordable and clean energy), SDG 8 (decent work and economic growth), and SDG 13 (climate action). Through this expo, we aim to showcase the latest advancements in solar technology, foster meaningful partnerships, and raise awareness about the critical role of renewable energy in our future.

I extend my heartfelt gratitude to all the participants, sponsors, and exhibitors who have contributed to making this event a success. A special thanks to the universities, including UET Peshawar, UoT Nowshera, and City University, for their active participation and for booking their stalls at ISE 2024. Your presence is invaluable in creating a vibrant and enriching environment for all attendees.

This year, we are proud to announce the establishment of the Steering Committee on Solar Energy (SCSE) at the Sarhad Chamber of Commerce and Industries, Peshawar. This initiative, led by our esteemed Chief Patron, Prof. Subhan Qureshi, aims to address the challenges faced by stakeholders and to further our commitment to sustainable energy solutions.

I would also like to take this opportunity to thank the companies such as Tesla PV (Absol Energy), Fox ESS, and Ziewnic, for their participation and support. Their contributions highlight the dynamic and rapidly evolving landscape of the solar industry.

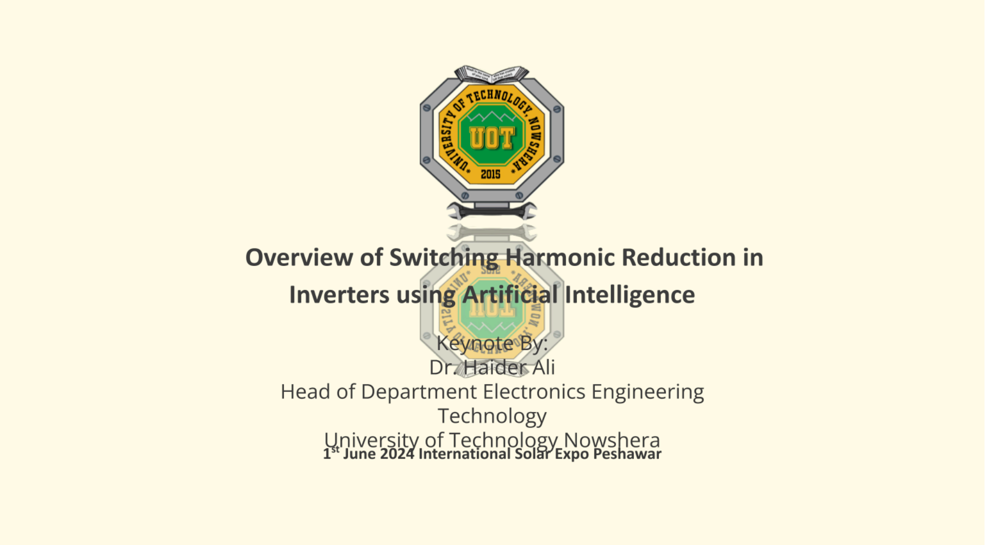
As we look to the future, we are excited about the potential to expand the reach of the International Solar Expo. We envision holding ISE in other countries, allowing for a broader exchange of ideas, technologies, and innovations. This global approach will help us tackle the pressing challenges of climate change and energy sustainability on an international scale.

I hope ISE 2024 provides you with valuable insights, fosters new collaborations, and inspires innovative solutions in the solar energy sector. Together, we can make significant strides toward a sustainable and energy-secure future.

Thank you for being a part of ISE 2024.

Keynote Lectures

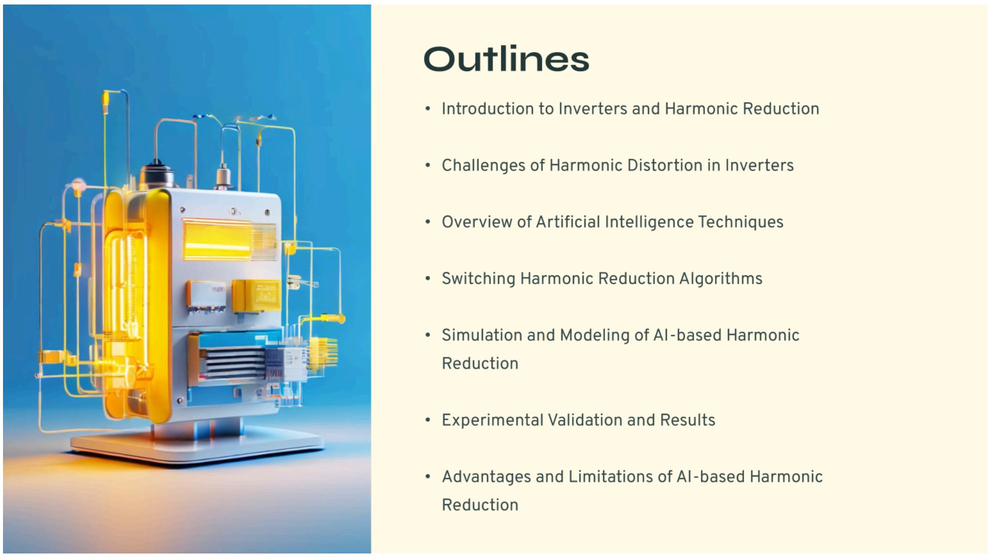
1. Dr Haider Ali, UOT, Nowshera



Overview of Switching Harmonic Reduction in Inverters using Artificial Intelligence

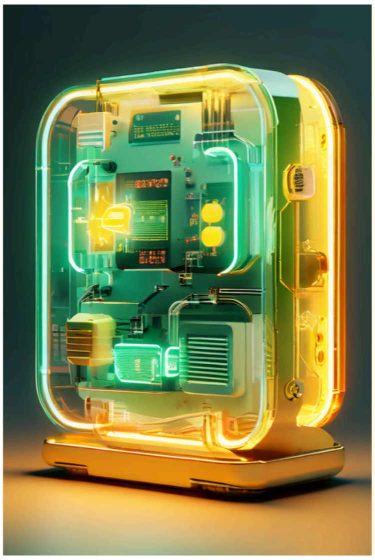
Keynote By:
Dr. Haider Ali
Head of Department Electronics Engineering Technology
University of Technology Nowshera

1st June 2024 International Solar Expo Peshawar



Outlines

- Introduction to Inverters and Harmonic Reduction
- Challenges of Harmonic Distortion in Inverters
- Overview of Artificial Intelligence Techniques
- Switching Harmonic Reduction Algorithms
- Simulation and Modeling of AI-based Harmonic Reduction
- Experimental Validation and Results
- Advantages and Limitations of AI-based Harmonic Reduction



Introduction

- Inverters are essential components in modern power systems, converting direct current (DC) into alternating current (AC) for various applications.
- However, the switching process in inverters can often lead to the generation of unwanted harmonics, which can have detrimental effects on power quality and system efficiency.
- This presentation explores how artificial intelligence (AI) techniques can be leveraged to effectively reduce these switching harmonics, ensuring clean and reliable power delivery.

Challenges of Harmonic Distortion in Inverters

1

Power Quality Issues

Harmonic distortion can cause voltage and current waveform deformation, leading to increased power losses, equipment overheating, and potential system failures.

2

Electromagnetic Interference

Switching harmonics can interfere with other electronic devices, causing electromagnetic compatibility (EMC) problems and disrupting sensitive equipment.

3

Reduced System Efficiency

Harmonics can decrease the overall efficiency of the power conversion process, reducing the energy efficiency of the inverter and the entire system.

4

Increased Maintenance Costs

Harmonic-related issues can lead to more frequent equipment maintenance and repairs, resulting in higher operating costs for the system.

Overview of Artificial Intelligence Techniques

Machine Learning

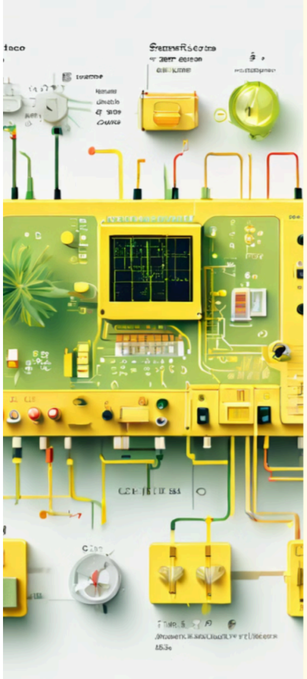
Supervised and unsupervised machine learning algorithms can be used to identify patterns in harmonic data and develop predictive models for harmonic mitigation.

Deep Learning

Deep neural networks can be trained to learn complex relationships between inverter parameters and harmonic distortion, enabling more accurate and adaptive control strategies.

Optimization Algorithms

Optimization techniques, such as genetic algorithms and particle swarm optimization, can be employed to find the optimal switching patterns and inverter parameters for harmonic reduction.



Switching Harmonic Reduction Algorithms

1

Pulse Width Modulation (PWM)

PWM-based techniques involve modulating the width of the inverter's switching pulses to selectively eliminate specific harmonic frequencies.

2

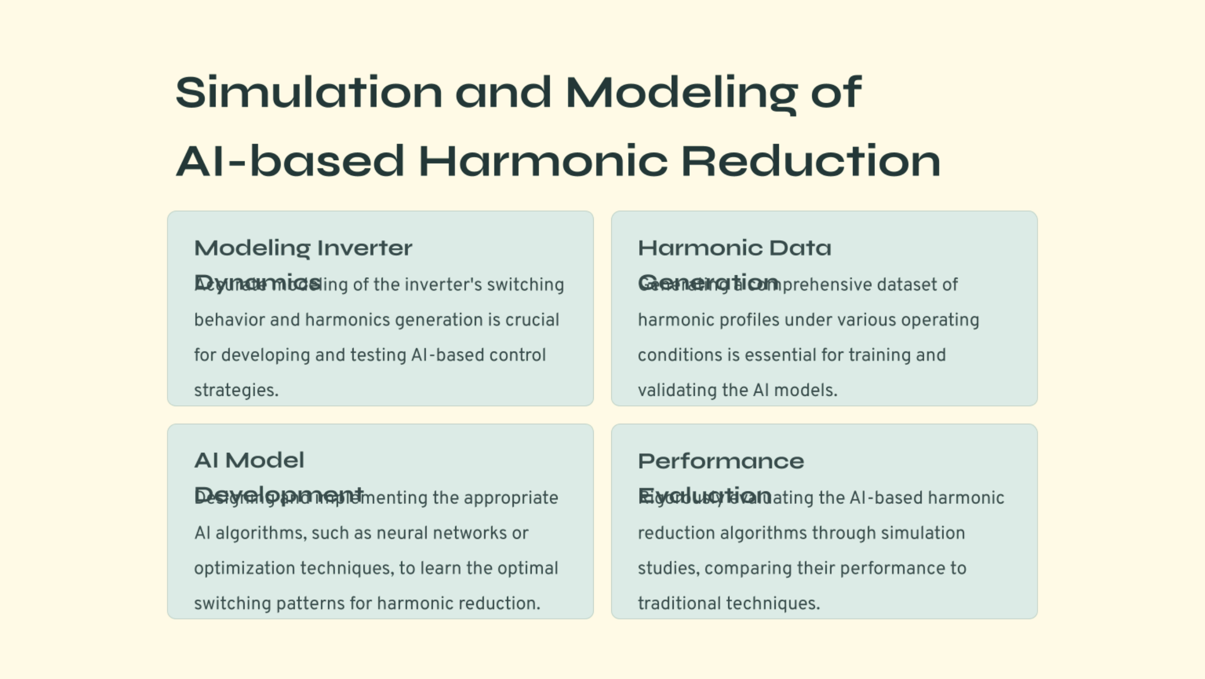
Space Vector Modulation (SVM)

SVM algorithms optimize the switching sequence and duration to minimize harmonic distortion in the output waveform.

3

Selective Harmonic Elimination (SHE)

SHE techniques use optimization methods to determine the optimal switching angles that eliminate targeted harmonics while maintaining the desired fundamental output.



Simulation and Modeling of AI-based Harmonic Reduction

Modeling Inverter Dynamics

Accurate modeling of the inverter's switching behavior and harmonics generation is crucial for developing and testing AI-based control strategies.

Harmonic Data Generation

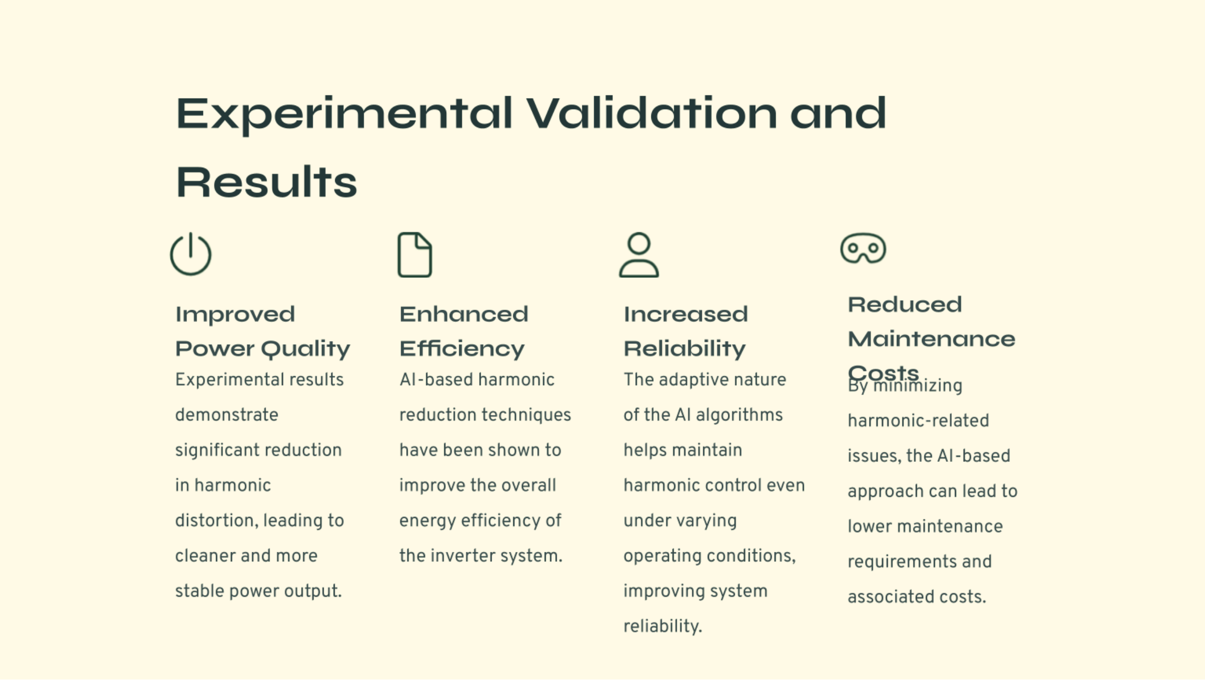
Generating a comprehensive dataset of harmonic profiles under various operating conditions is essential for training and validating the AI models.

AI Model Development

Designing and implementing the appropriate AI algorithms, such as neural networks or optimization techniques, to learn the optimal switching patterns for harmonic reduction.

Performance Evaluation

Rigorously evaluating the AI-based harmonic reduction algorithms through simulation studies, comparing their performance to traditional techniques.



Experimental Validation and Results

Improved Power Quality

Experimental results demonstrate significant reduction in harmonic distortion, leading to cleaner and more stable power output.

Enhanced Efficiency

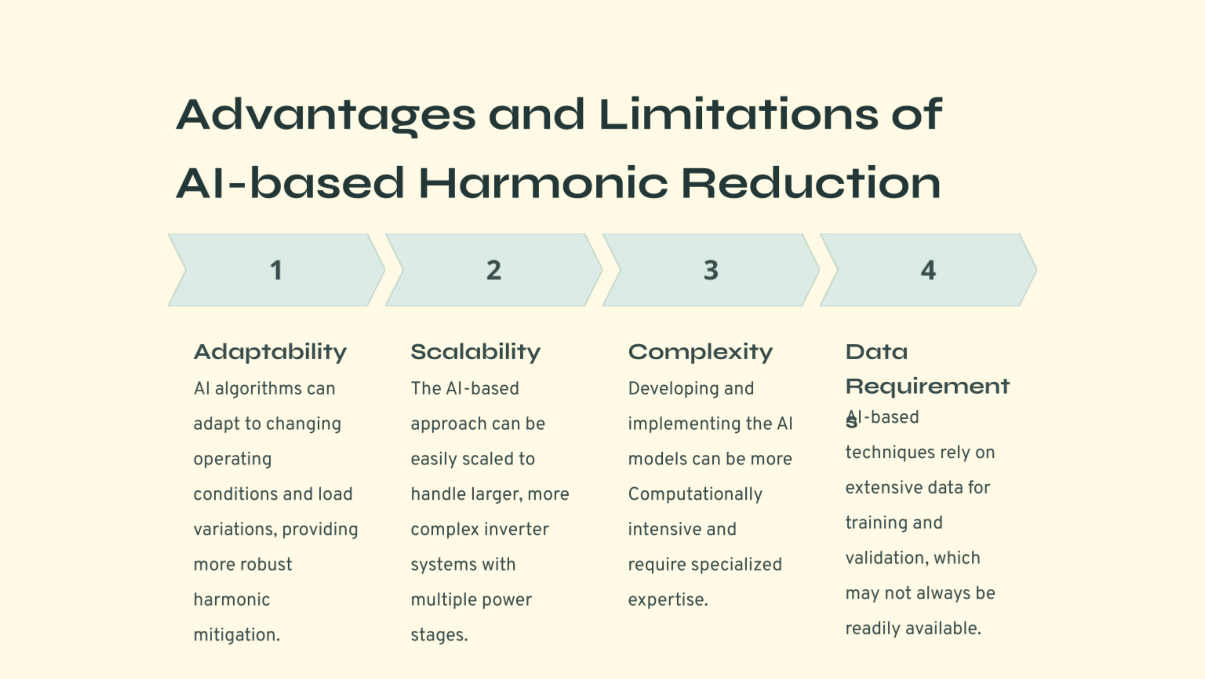
AI-based harmonic reduction techniques have been shown to improve the overall energy efficiency of the inverter system.

Increased Reliability

The adaptive nature of the AI algorithms helps maintain harmonic control even under varying operating conditions, improving system reliability.

Reduced Maintenance Costs

By minimizing harmonic-related issues, the AI-based approach can lead to lower maintenance requirements and associated costs.



Advantages and Limitations of AI-based Harmonic Reduction

1

Adaptability

AI algorithms can adapt to changing operating conditions and load variations, providing more robust harmonic mitigation.

2

Scalability

The AI-based approach can be easily scaled to handle larger, more complex inverter systems with multiple power stages.

3

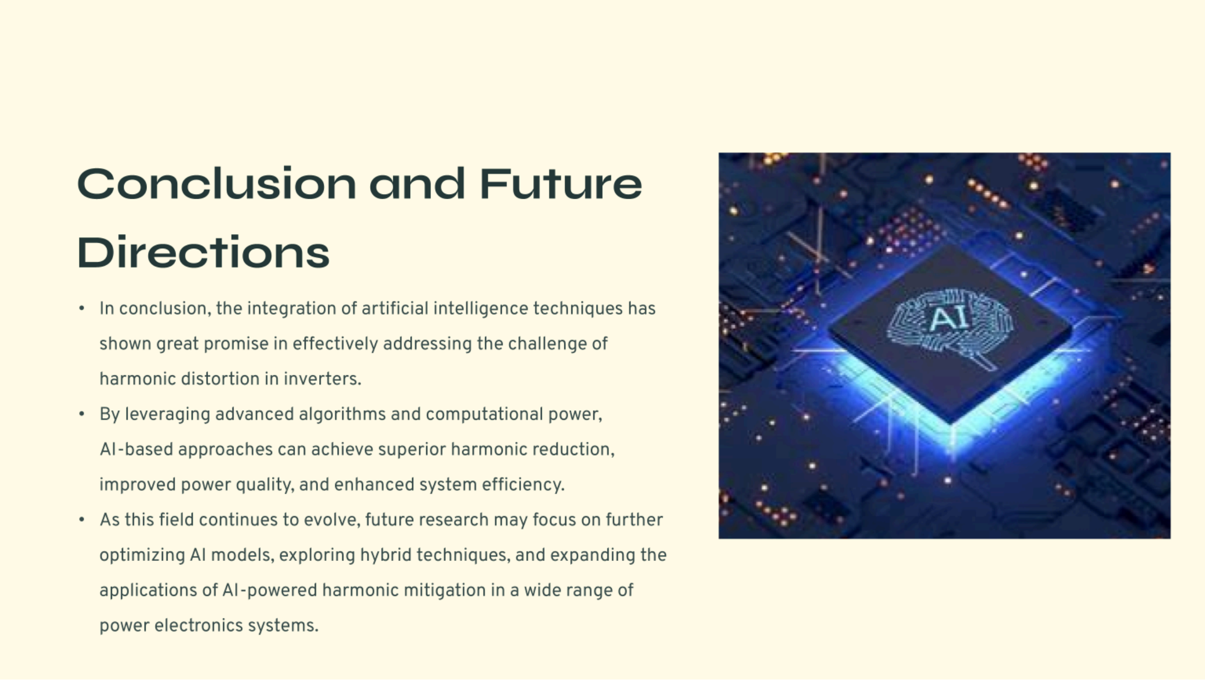
Complexity

Developing and implementing the AI models can be more Computationally intensive and require specialized expertise.

4

Data Requirements

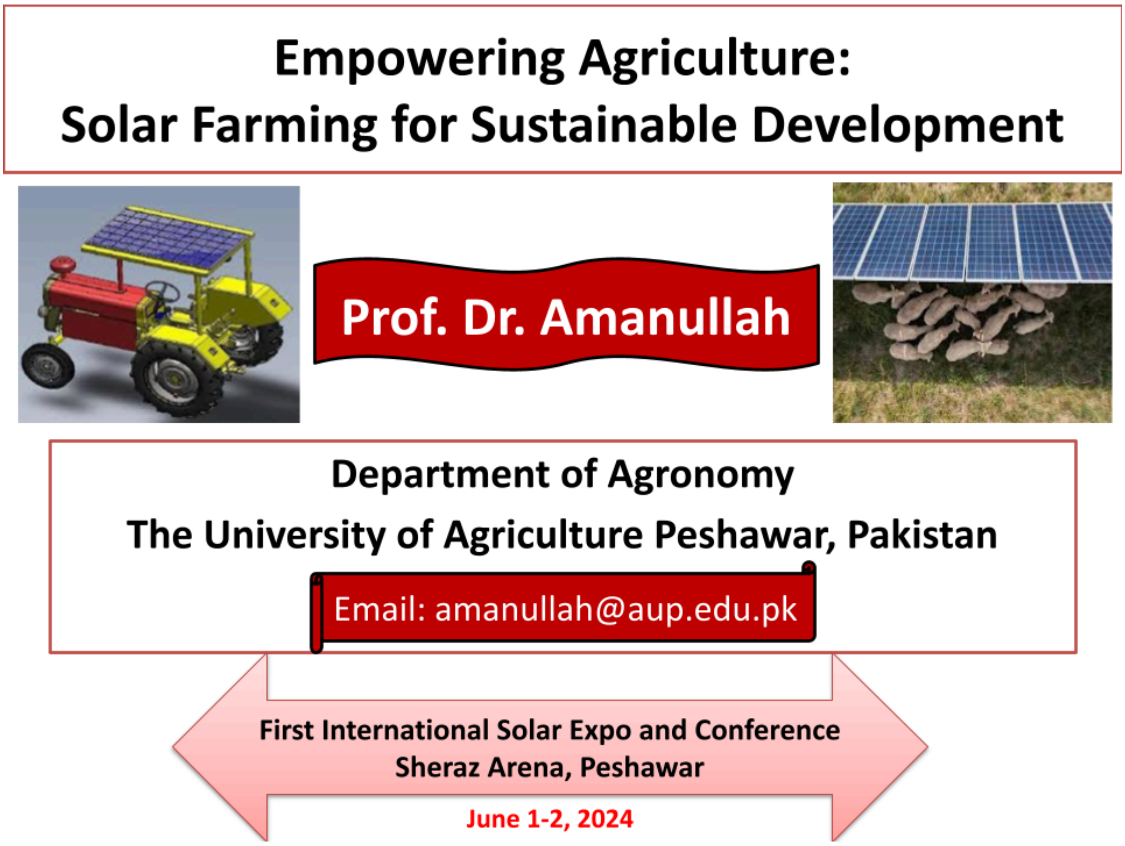
AI-based techniques rely on extensive data for training and validation, which may not always be readily available.



Conclusion and Future Directions

- In conclusion, the integration of artificial intelligence techniques has shown great promise in effectively addressing the challenge of harmonic distortion in inverters.
- By leveraging advanced algorithms and computational power, AI-based approaches can achieve superior harmonic reduction, improved power quality, and enhanced system efficiency.
- As this field continues to evolve, future research may focus on further optimizing AI models, exploring hybrid techniques, and expanding the applications of AI-powered harmonic mitigation in a wide range of power electronics systems.

2. Prof Amanullah, Univ Agric Peshawar

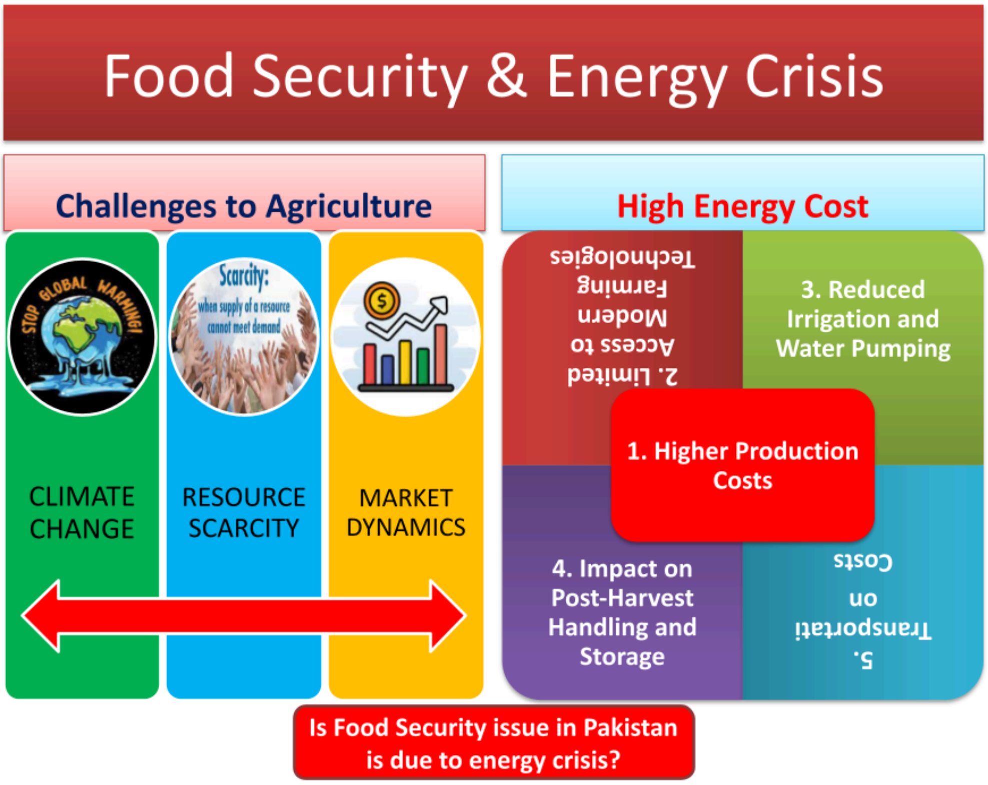


Empowering Agriculture:
Solar Farming for Sustainable Development

Prof. Dr. Amanullah

Department of Agronomy
The University of Agriculture Peshawar, Pakistan
Email: amanullah@aup.edu.pk

First International Solar Expo and Conference
Sheraz Arena, Peshawar
June 1-2, 2024



Food Security & Energy Crisis

Challenges to Agriculture

CLIMATE CHANGE

RESOURCE SCARCITY

MARKET DYNAMICS

High Energy Cost

1. Higher Production Costs

2. Limited Access to Modern Farming Technologies

3. Reduced Irrigation and Water Pumping

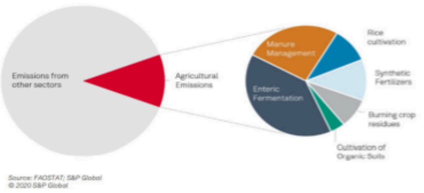
4. Impact on Post-Harvest Handling and Storage

5. Transportation Costs

Is Food Security issue in Pakistan is due to energy crisis?

Decarbonizing Agriculture?

- Agriculture contributes significantly to climate change through greenhouse gas emissions, particularly carbon dioxide, methane and nitrous oxide (**11%**).
- Decarbonizing agriculture refers to the process of taking deliberate actions to reduce the amount of carbon emissions generated by various agricultural practices and processes.
- In simpler terms, it means finding ways to make farming and agriculture more environmentally friendly in terms of carbon dioxide (CO_2) and other greenhouse gas emissions.



Source: FAOSTAT; S&P Global
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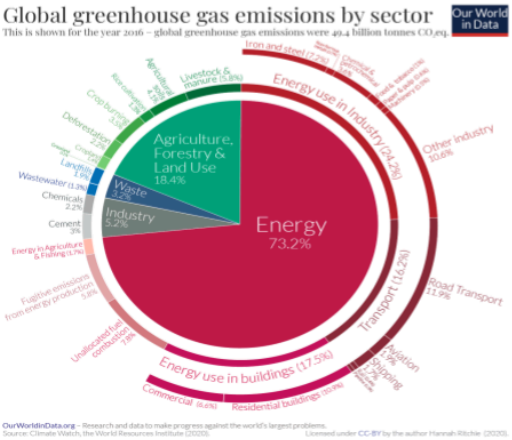
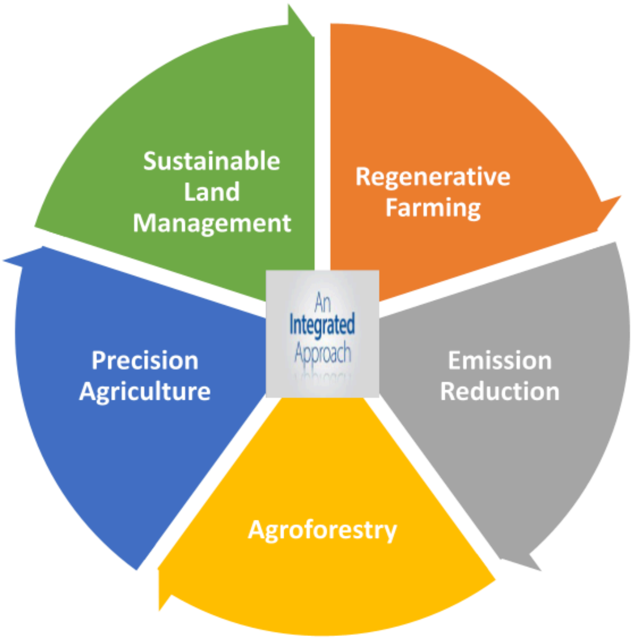


Global greenhouse gas emissions by sector

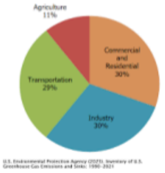
This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO_2eq.

OurWorldinData.org – Research and data to make progress against the world's largest problems.
Source: Climate Watch, the World Resources Institute (2020).
Licensed under CC-BY by the author Hannah Ritchie (2020).

How to achieve this goal?
(Decarbonizing Agriculture)
We need an integrated approach



Sustainable Land Management
Regenerative Farming
Precision Agriculture
Emission Reduction
Agroforestry
An Integrated Approach



U.S. Environmental Protection Agency (2023). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021

1. Sustainable Land Management

- Sustainable Land Management is a set of practices and principles aimed at preserving and enhancing the health of soils and the environment while maintaining or increasing agricultural productivity.
- Sustainable land management practices such as minimal tillage, cover cropping, and crop rotation are fundamental components of decarbonizing agriculture.
- SLM contribute to healthier soils, increased carbon sequestration, and reduced environmental impacts.
- Farmers must adopt practices that preserve and improve soil health.
- Healthy soils can capture and store carbon, which helps mitigate climate change.
- Sustainable land management techniques include minimal tillage, cover cropping, and crop rotation.

Solar Farming?

- Today, we're going to learn about "**solar farming**" and how it helps make our farms and the environment better.
- Solar farming is like giving power to farms using **sunlight**, which means farmers can **save money** on electricity, and **reducing costs**.
- It's not just about saving money. Solar farming helps our planet stay healthy by using **clean energy** from the sun.
- Plus, it creates **new jobs** and helps farms grow, which is really important for our communities.

Why Solar Farming is Great?

Solar farming is awesome for farms and the Earth!

Saves Money:
- Farmers don't have to pay a lot for electricity because the sun's energy is free!
- This means more money for farmers to grow yummy fruits, veggies, cereals and pulses, etc.

Helps the Earth:
- Using solar power makes our planet happy!
- When farms use solar energy, they make less pollution, like **dirty smoke**.
- It's like giving the Earth a big, **clean hug**!

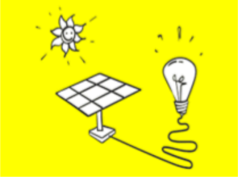
Solar Farming: A Superhero for the Planet

Getting Clean Energy:
- Solar farming helps us get energy from the sun, which is clean and never runs out!
- This means we don't have to use up Earth's precious resources.

Less Pollution:
- Solar farming makes less pollution than using dirty fuels.
- This helps keep our air and water clean for animals and plants.

Saving Land for Nature:
- Solar panels don't need a lot of space, so there's more land left for animals and plants.
- This means more habitats for animals to live in and more trees to clean the air.

Feeding Everyone:
- Solar farming helps with a big goal: making sure everyone has enough food.
- With clean energy, farms can grow more food without harming the planet.



Solar Farming: Growing Money and Jobs

Solar farming isn't just good for the Earth—it's good for making money too!

More Money for Farmers:

- When farms use solar energy, they save a lot of money on electricity bills.
- This extra money can help farmers buy new tools and grow even more food.

Creating New Jobs:

- Solar farming also creates new jobs for people in the solar energy industry.
- These are jobs like building and taking care of solar panels.
- More jobs mean more opportunities for people in our communities.

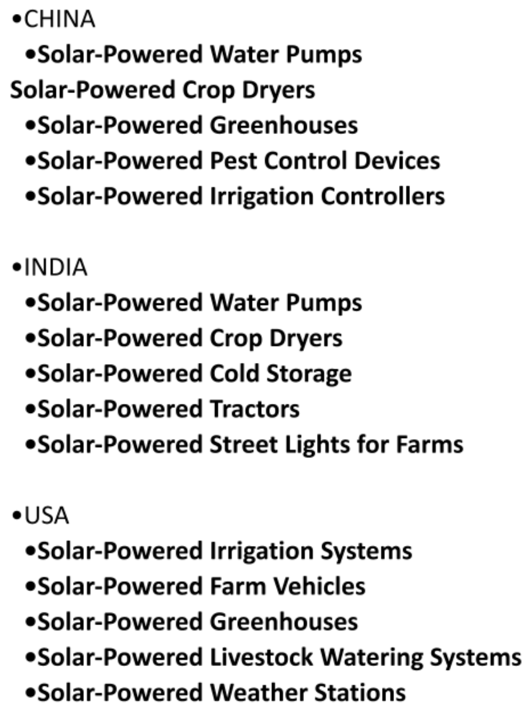
Bringing Electricity to Faraway Places:

- Some farms are in places where it's hard to get electricity.
- Solar farming helps these farms get the power they need to grow food and run their machines.

Some examples of solar-powered agricultural machines

- **Solar-Powered Water Pumps**
- **Solar-Powered Crop Dryers**
- **Solar-Powered Pest Control Devices**
- **Solar-Powered Electric Fences**
- **Solar-Powered Tractors and Farm Vehicles**

- **Solar-Powered Greenhouses**
- **Solar-Powered Refrigeration Units**
- **Solar-Powered Sensors and Monitoring Systems**
- **Solar-Powered Irrigation Controllers**
- **Solar-Powered Grain Mills**

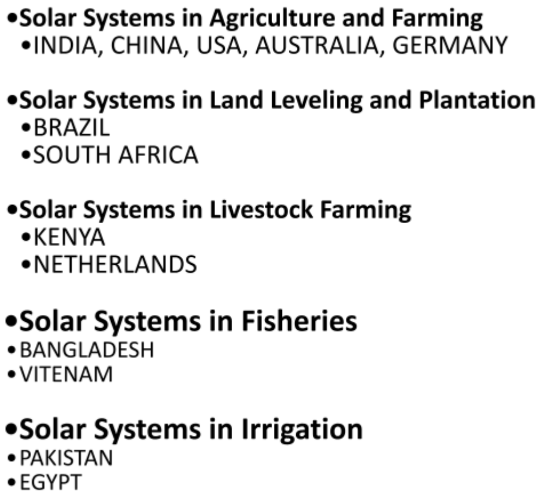


- CHINA
  - **Solar-Powered Water Pumps**

  Solar-Powered Crop Dryers
  - **Solar-Powered Greenhouses**
  - **Solar-Powered Pest Control Devices**
  - **Solar-Powered Irrigation Controllers**

- INDIA
  - **Solar-Powered Water Pumps**
  - **Solar-Powered Crop Dryers**
  - **Solar-Powered Cold Storage**
  - **Solar-Powered Tractors**
  - **Solar-Powered Street Lights for Farms**

- USA
  - **Solar-Powered Irrigation Systems**
  - **Solar-Powered Farm Vehicles**
  - **Solar-Powered Greenhouses**
  - **Solar-Powered Livestock Watering Systems**
  - **Solar-Powered Weather Stations**



- **Solar Systems in Agriculture and Farming**
  - INDIA, CHINA, USA, AUSTRALIA, GERMANY

- **Solar Systems in Land Leveling and Plantation**
  - BRAZIL
  - SOUTH AFRICA

- **Solar Systems in Livestock Farming**
  - KENYA
  - NETHERLANDS

- **Solar Systems in Fisheries**
- BANGLADESH
- VITENAM

- **Solar Systems in Irrigation**
- PAKISTAN
- EGYPT

Overcoming Challenges in Solar Farming

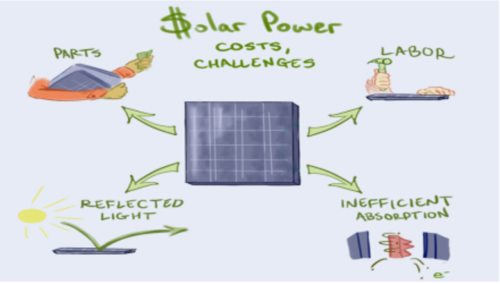
Starting with solar panels can be tricky, but there are solutions!

Challenges:

- It can be expensive to get started with solar panels.
- Sometimes, farms might not have the right equipment or know-how.

Solutions:

- **Government help**: The government can offer support, like money to help buy solar panels.
- **Training and resources**: There are programs to teach farmers how to use solar power.

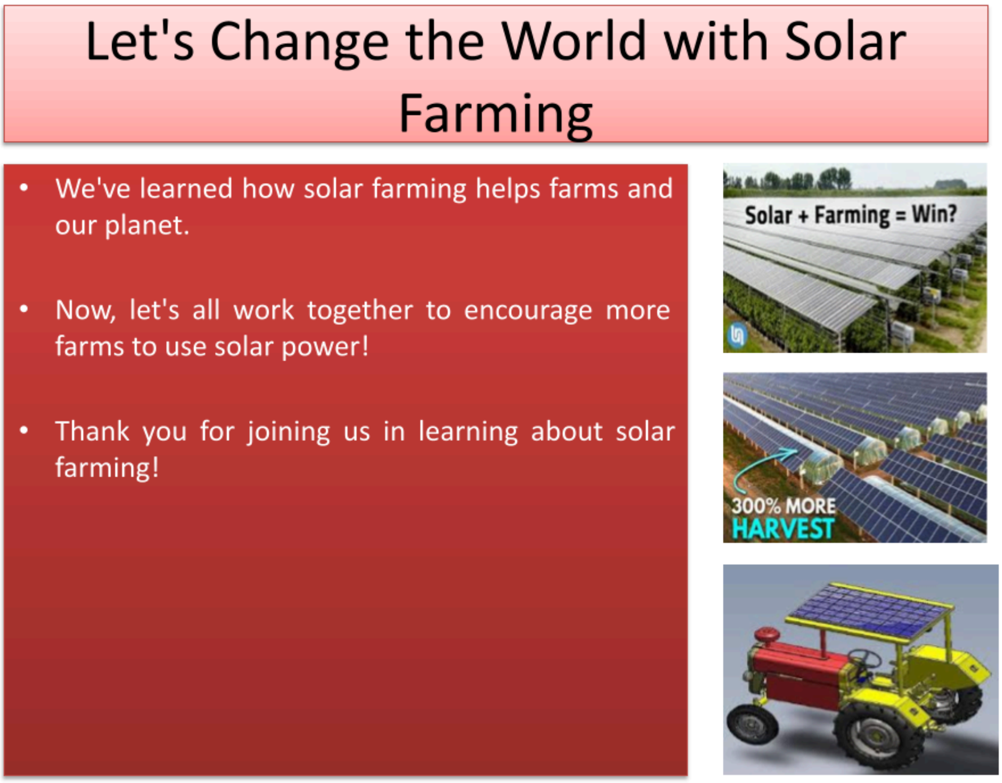


Advantages

- Renewable & pollution free
- Reduce electricity bill
- Less maintenance
- Diverse application
- Can be stored in batteries
- More in summer

Disadvantages

- Needs lot of space
- High initial costs
- No solar power at night & clods
- DC equipment's are expensive
- Expensive batteries
- Less in winter

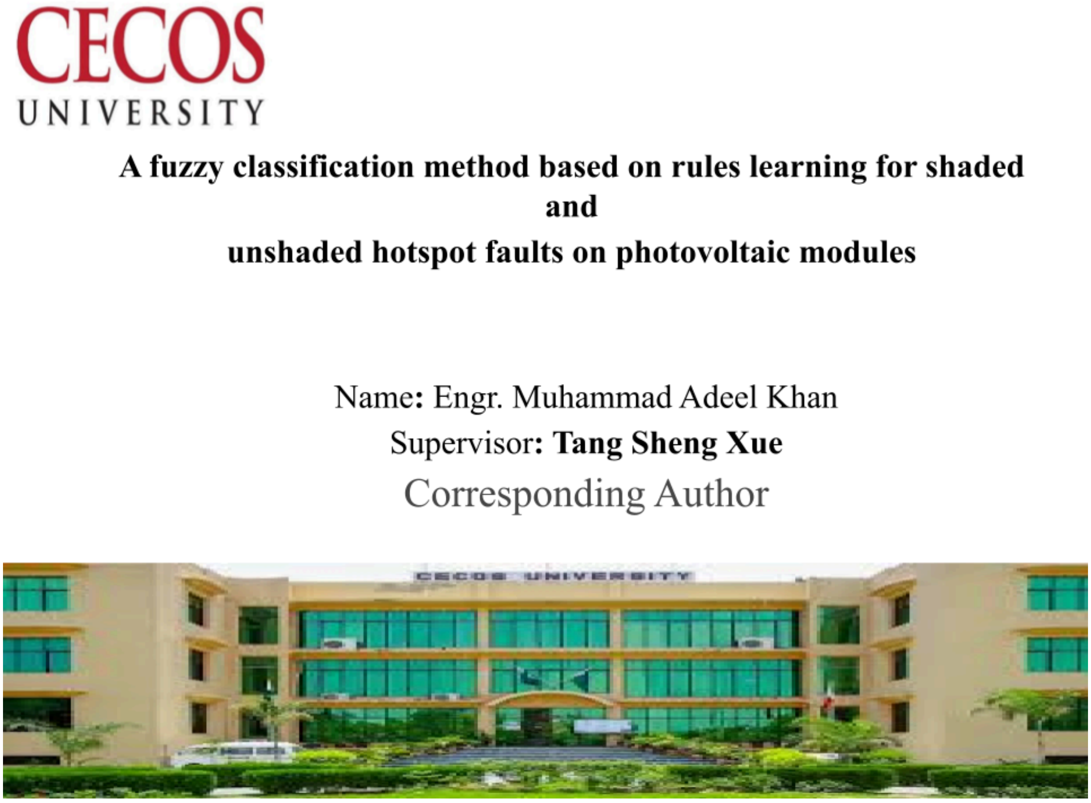


Solar + Farming = Win?
300% MORE
HARVEST

Let's Change the World with Solar Farming

- We've learned how solar farming helps farms and our planet.
- Now, let's all work together to encourage more farms to use solar power!
- Thank you for joining us in learning about solar farming!

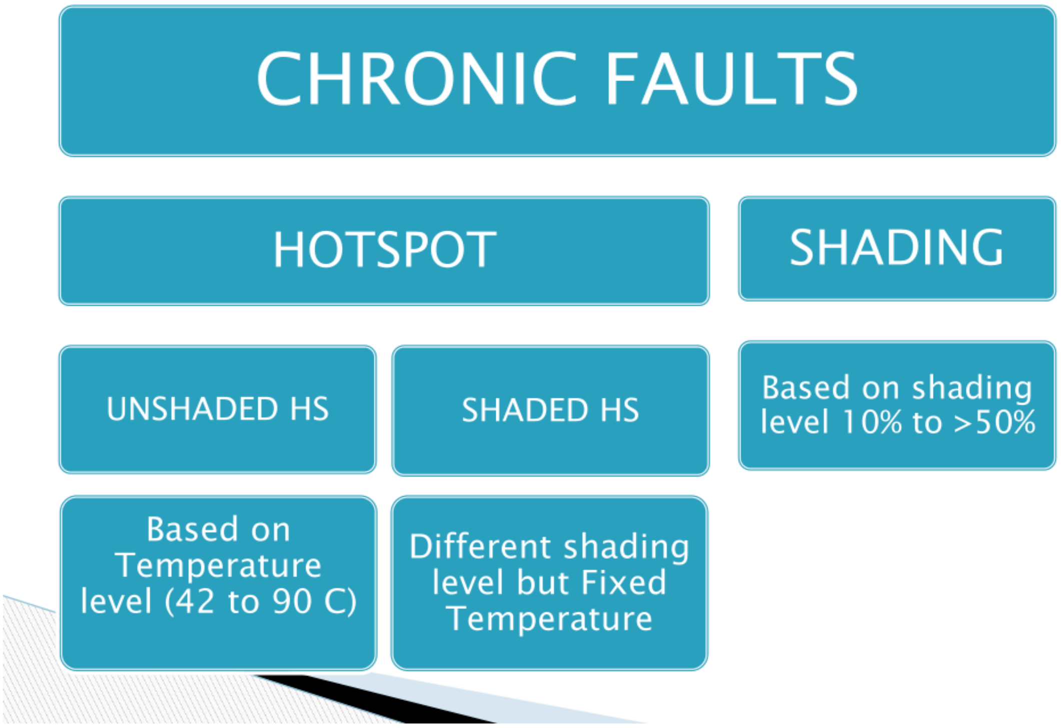
3. Engr M Adeel Khan, CECOS University



CECOS UNIVERSITY

A fuzzy classification method based on rules learning for shaded and unshaded hotspot faults on photovoltaic modules

Name**:** Engr. Muhammad Adeel Khan
Supervisor**: Tang Sheng Xue**
Corresponding Author



CHRONIC FAULTS

HOTSPOT

SHADING

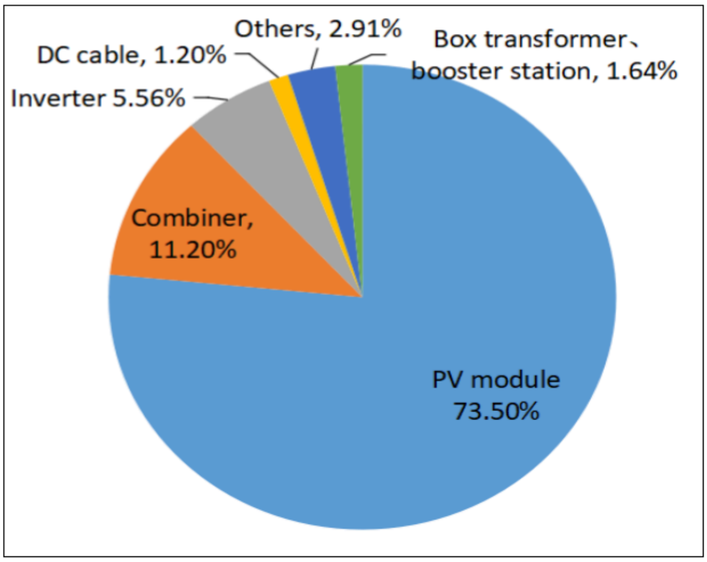
UNSHADED HS

SHADED HS

Based on shading level 10% to >50%

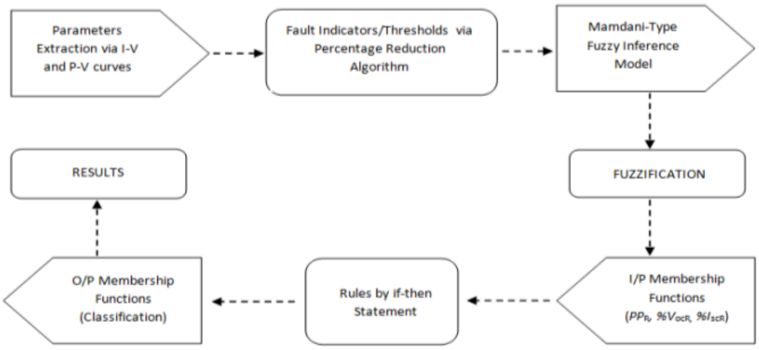
Based on Temperature level (42 to 90 C)

Different shading level but Fixed Temperature



Fault statistics of a photovoltaic power generation system

Overview of Overall Fault Detection and Classification Technique


Parameters Extraction via I-V and P-V curves

Fault Indicators/Thresholds via Percentage Reduction Algorithm

Mamdani-Type Fuzzy Inference Model

FUZZIFICATION

I/P Membership Functions (PP_R, $\%V_{ocR}$, $\%I_{scR}$)

Rules by if-then Statement

O/P Membership Functions (Classification)

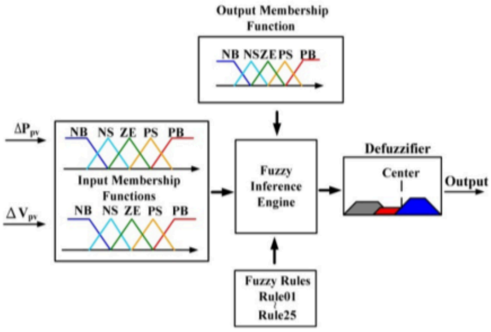
RESULTS

- Parameters are extracted from the features of I-V and P-V characteristic curves of different shading and HS faults.
- Three parameters (P, V_{oc}, and I_{sc}) were used in the Percentage Reduction Algorithm to get the fault indicators or threshold limits in the second step. These ratios are used in the fuzzy logic system as input member functions.
- The fuzzy logic system comprises all the remaining steps of the classification method from the fuzzy inference model to the results.

Fuzzy Logic System

- Fuzzy Logic and traditional crisp logic?
- The membership concept and Human perceptions.
- Fuzzy set theory and Rules
- Applications of Fuzzy logic system

- The main purpose of a Fuzzy inference model in the PV fault detection algorithm is to detect calculated points which cannot be classified by the high and low limits of various shading and HS faults. Thus, it will increase the overall detection accuracy for PV fault detection.



Schematic of fuzzy inference model

Mamdani-type fuzzy Inference Model

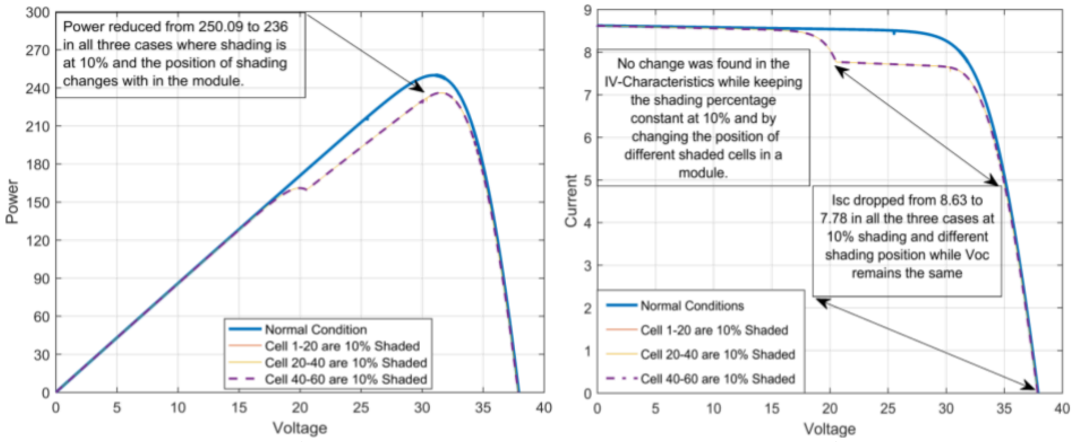
- What is Fuzzy Inference?
- What are the types of Fuzzy inference model?
- Why Mamdani-type fuzzy inference
- Steps of Mamdani Inference

Fuzzification of Input Variable
Fuzzy operator
Implication method
Aggregation method
De-Fuzzification

- Generally in literature, there are three types of fuzzy inference systems such as Mamdani, Sugeno, and Tsukamoto.
- A Mamdani-type Fuzzy Inference System (FIS) model is presented in this work because the output results returned by the Mamdani model are based on the If-Then method;
- Using ''if'' Mamdani type inference model determines whether the input variable provided by the user belongs to the membership function, while ''Then'' convert the value into the fuzzy set.

Results and Discussion

P-V and I-V Curves of Shading fault

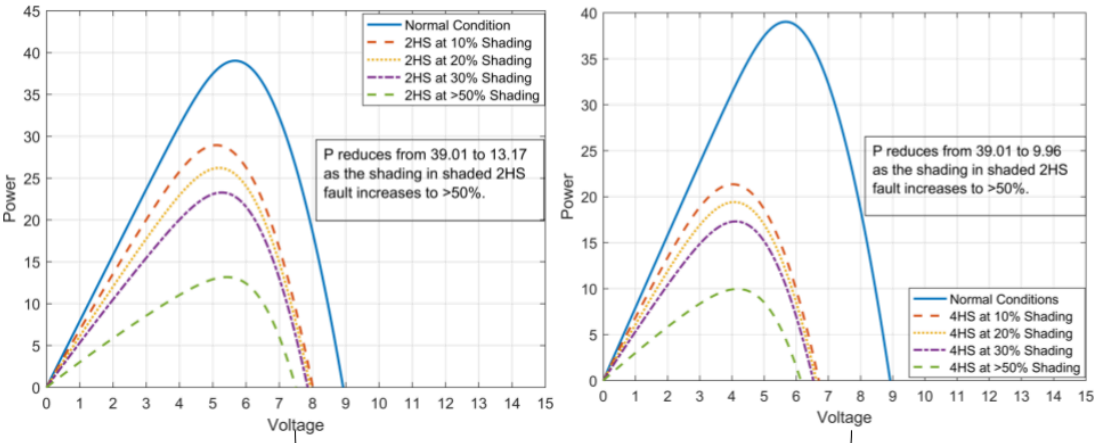

Power reduced from 250.09 to 236 in all three cases where shading is at 10% and the position of shading changes with in the module.

No change was found in the IV-Characteristics while keeping the shading percentage constant at 10% and by changing the position of different shaded cells in a module.

Isc dropped from 8.63 to 7.78 in all the three cases at 10% shading and different shading position while Voc remains the same

P-V and I-V curves of shading PV at different position and fixed irradiance

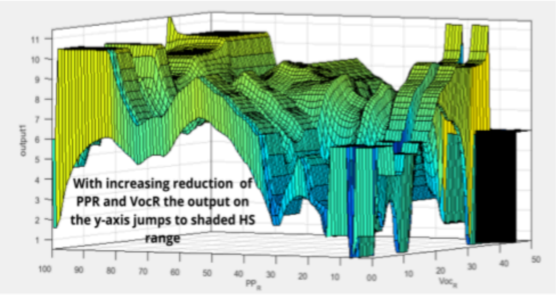
P-V and I-V Curves of HS fault with shaded and un-shaded conditions


P reduces from 39.01 to 13.17 as the shading in shaded 2HS fault increases to >50%.

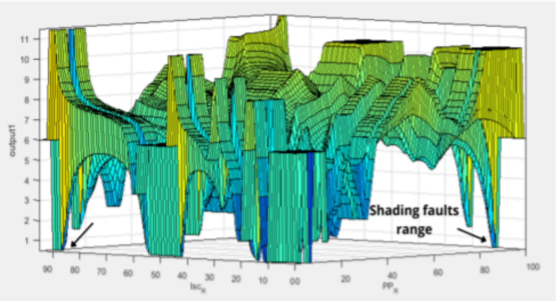
P reduces from 39.01 to 9.96 as the shading in shaded 2HS fault increases to >50%.

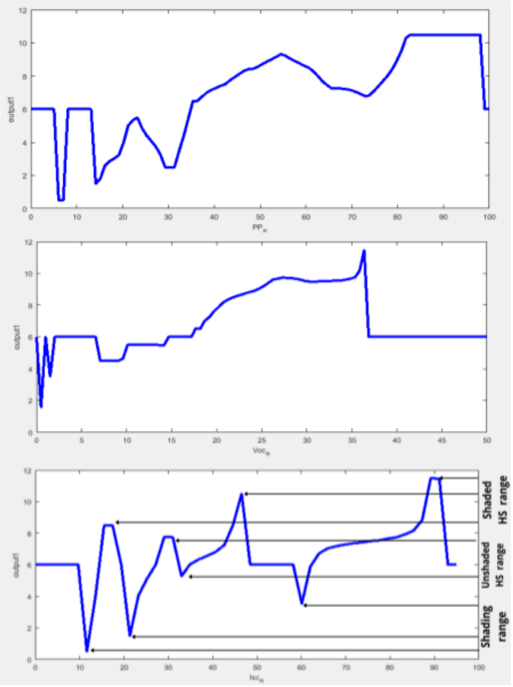
P-V Curves of Hotspot with Shaded Condition at different Temp and Shading levels

Faults Classification Using Mamdani-type Fuzzy inference



(a)



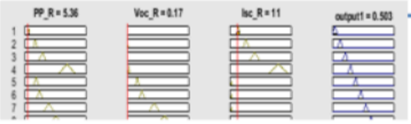


Case Studies

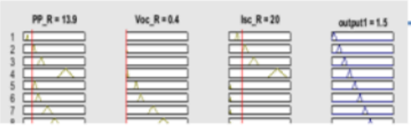
Case Study 1

Low shaded fault threshold
PPR = 5.24-7.86
VocR = 0.13-0.20
IscR = 10.08-15.12
Output Range for LS fault = 0-1

Moderate shaded fault threshold
PPR = 13.9-20.88
VocR = 0.37-0.57
IscR = 19.81-29.72
Output Range for LS fault = 0-1



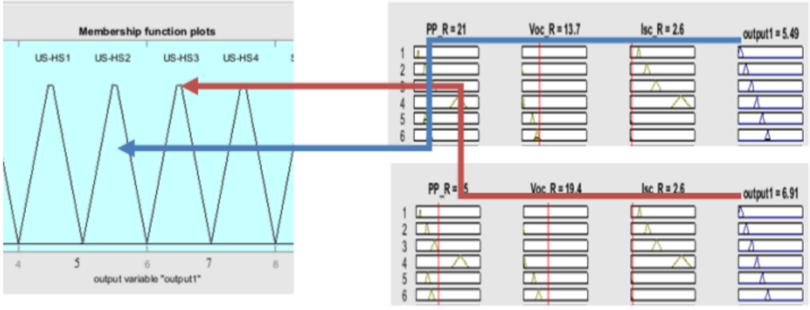
PPR = 5.36
VocR = 0.17
IscR = 11
Output = 0.503 ∈ [0-1] which is Low shaded fault



PPR = 13.9
VocR = 0.4
IscR = 20
Output = 1.5 ∈ [1-2] which is Moderate shaded fault

Case Study 1 (Low shaded and Moderate shaded fault)

Case Study 2



Unshaded HS fault at T=50 thresholds
PPR = 21 € 19.43-29.14
VocR = 13.7 € 9.52-14.29
IscR = 2.6 € 2.53-3.79
Output Range for US-HS2 fault = 5.49 € [5-6]

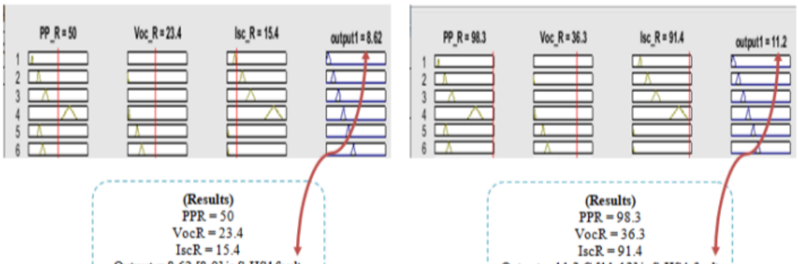
Unshaded HS fault at T=72 thresholds
PPR = 35 € [31.35-47.02]
VocR = 19.4 € [17.48-26.23]
IscR = 2.6 € [2.53-3.79]
Output Range for US-HS3 fault = 6.91 € [6-7]

Case Study 2 (unshaded HS fault at T=50 and T=72)

Case Study 3

Shaded HS fault at 10% shading thresholds
PPR = 36.68-55.02
VocR = 18.27-27.41
IscR = 12.29-18.44
Output Range for S-HS1 fault = [8-9]

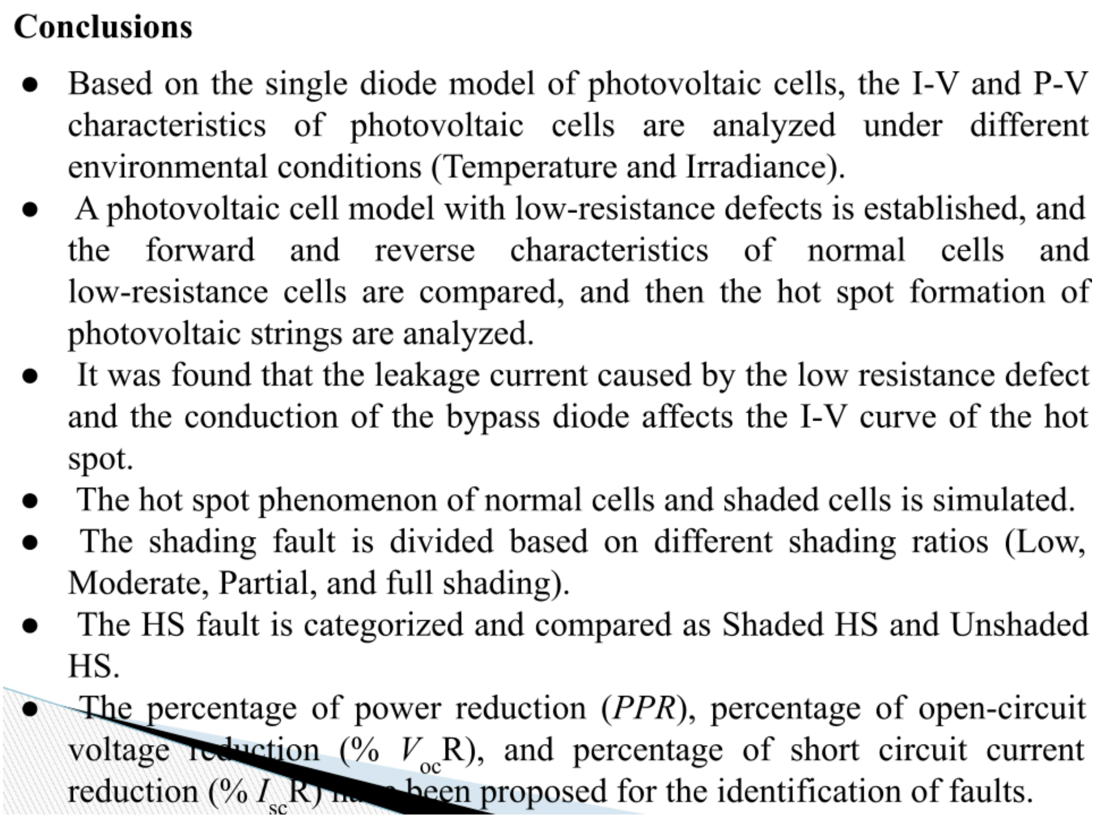
Shaded HS fault at >50% shading thresholds
PPR = 65.64-98.47
VocR = 24.32-36.49
IscR = 60.96-91.44
Output Range for S-HS4 fault = [11-12]



(Results)
PPR = 50
VocR = 23.4
IscR = 15.4
Output = 8.62 [8-9] is S-HS1 fault

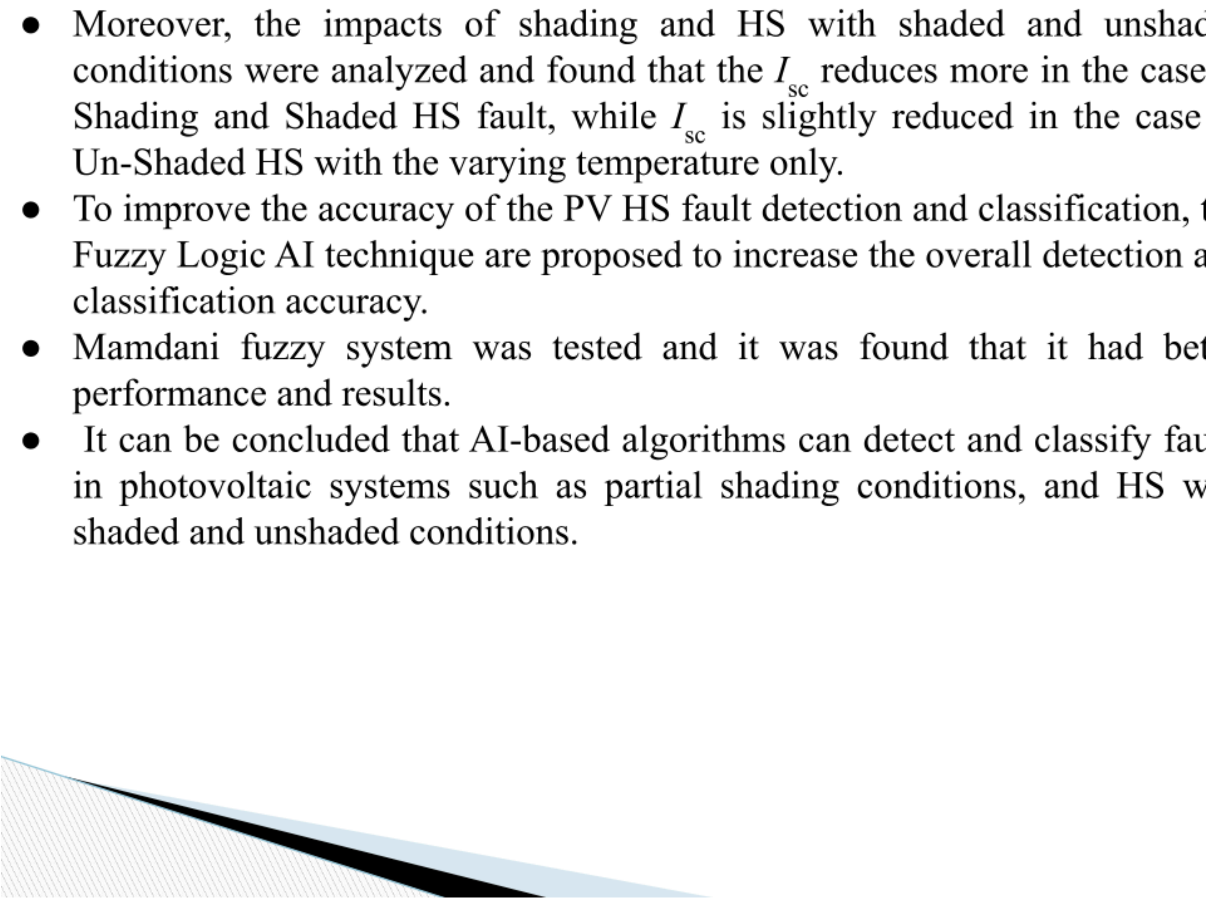
(Results)
PPR = 98.3
VocR = 36.3
IscR = 91.4
Output = 11.2 € [11-12] is S-HS4 fault

Case Study 3 (shaded HS fault at different shading levels)



Conclusions

- Based on the single diode model of photovoltaic cells, the I-V and P-V characteristics of photovoltaic cells are analyzed under different environmental conditions (Temperature and Irradiance).
- A photovoltaic cell model with low-resistance defects is established, and the forward and reverse characteristics of normal cells and low-resistance cells are compared, and then the hot spot formation of photovoltaic strings are analyzed.
- It was found that the leakage current caused by the low resistance defect and the conduction of the bypass diode affects the I-V curve of the hot spot.
- The hot spot phenomenon of normal cells and shaded cells is simulated.
- The shading fault is divided based on different shading ratios (Low, Moderate, Partial, and full shading).
- The HS fault is categorized and compared as Shaded HS and Unshaded HS.
- The percentage of power reduction (*PPR*), percentage of open-circuit voltage reduction (% V_{oc}R), and percentage of short circuit current reduction (% I_{sc}R) have been proposed for the identification of faults.



- Moreover, the impacts of shading and HS with shaded and unshac conditions were analyzed and found that the I_{sc} reduces more in the case Shading and Shaded HS fault, while I_{sc} is slightly reduced in the case Un-Shaded HS with the varying temperature only.
- To improve the accuracy of the PV HS fault detection and classification, t Fuzzy Logic AI technique are proposed to increase the overall detection a classification accuracy.
- Mamdani fuzzy system was tested and it was found that it had bet performance and results.
- It can be concluded that AI-based algorithms can detect and classify fau in photovoltaic systems such as partial shading conditions, and HS w shaded and unshaded conditions.

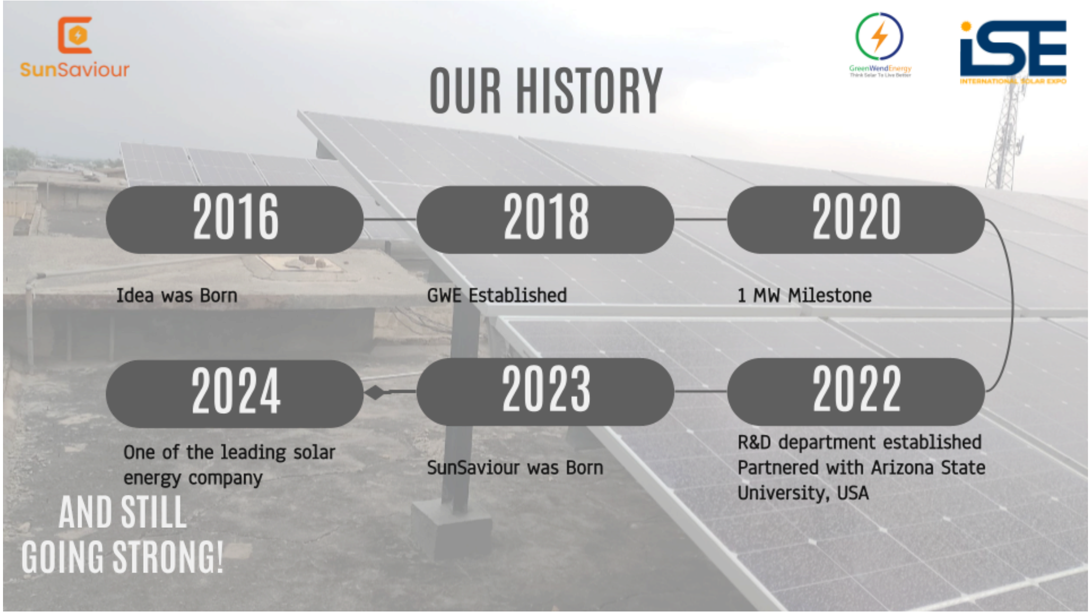
4. Izaz Qureshi, GreenWend Energy Pvt Ltd

SunSaviour

GREENWEND ENERGY

Think Solar To Live Better

GreenWendEnergy



SunSaviour

OUR HISTORY

2016

Idea was Born

2018

GWE Established

2020

1 MW Milestone

2022

R&D department established
Partnered with Arizona State University, USA

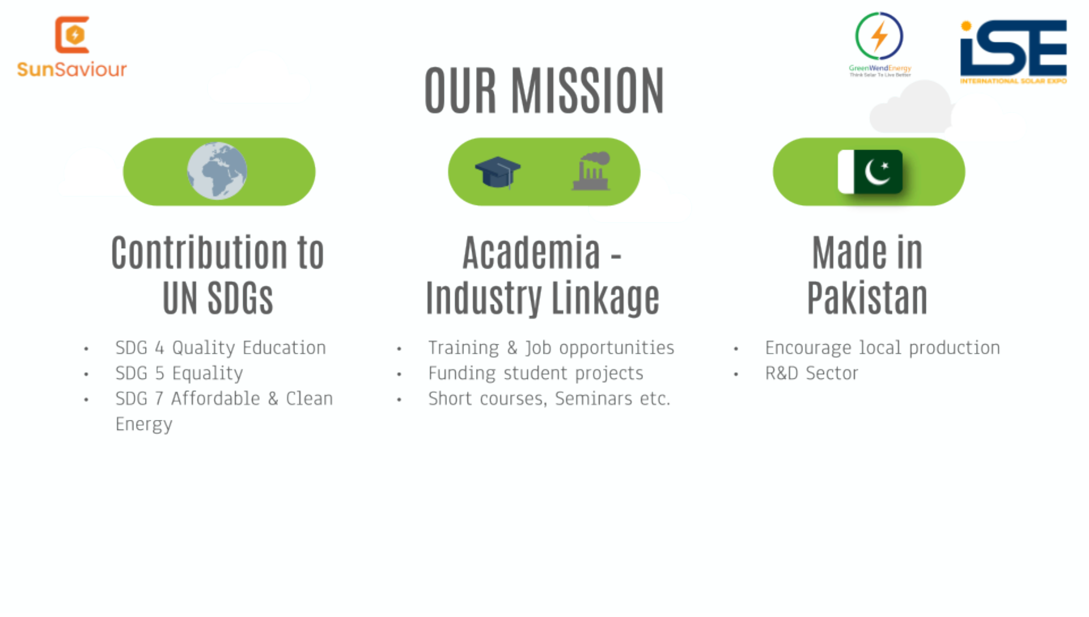
2023

SunSaviour was Born

2024

One of the leading solar energy company

AND STILL GOING STRONG!


SunSaviour
GreenWendEnergy
iSE
INTERNATIONAL SOLAR EXPO

OUR MISSION

Contribution to UN SDGs

- SDG 4 Quality Education
- SDG 5 Equality
- SDG 7 Affordable & Clean Energy

Academia - Industry Linkage

- Training & Job opportunities
- Funding student projects
- Short courses, Seminars etc.

Made in Pakistan

- Encourage local production
- R&D Sector

TOP PROJECTS

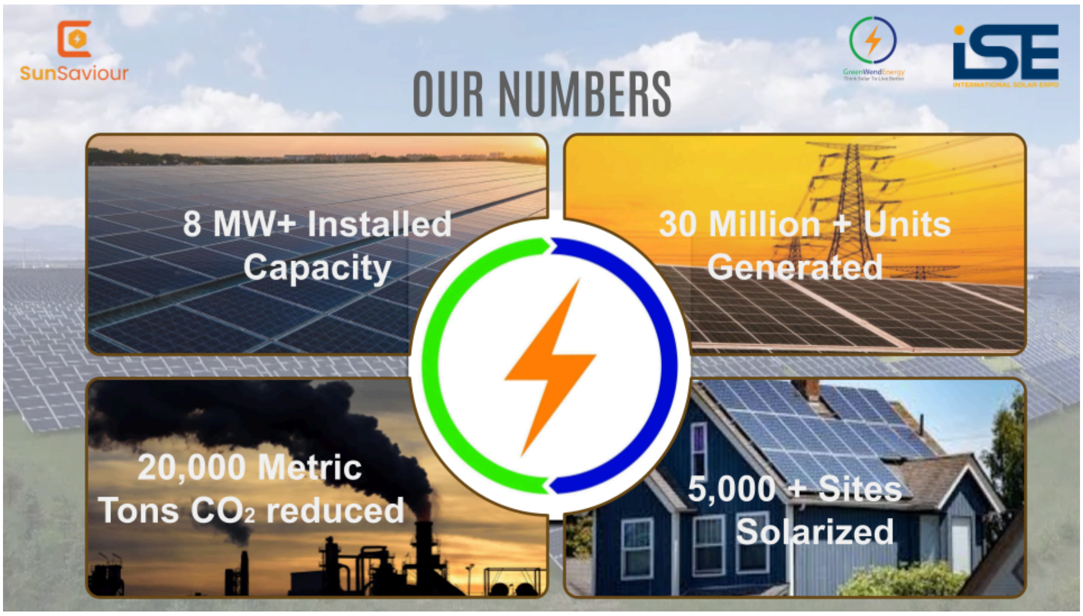
1000 Houses Solarization In Upper Chitral

TOP PROJECTS

1600 Schools Solarization In Hazara Region

TOP PROJECTS

Trainings for Underprivileged



SunSaviour

OUR NUMBERS

8 MW+ Installed Capacity

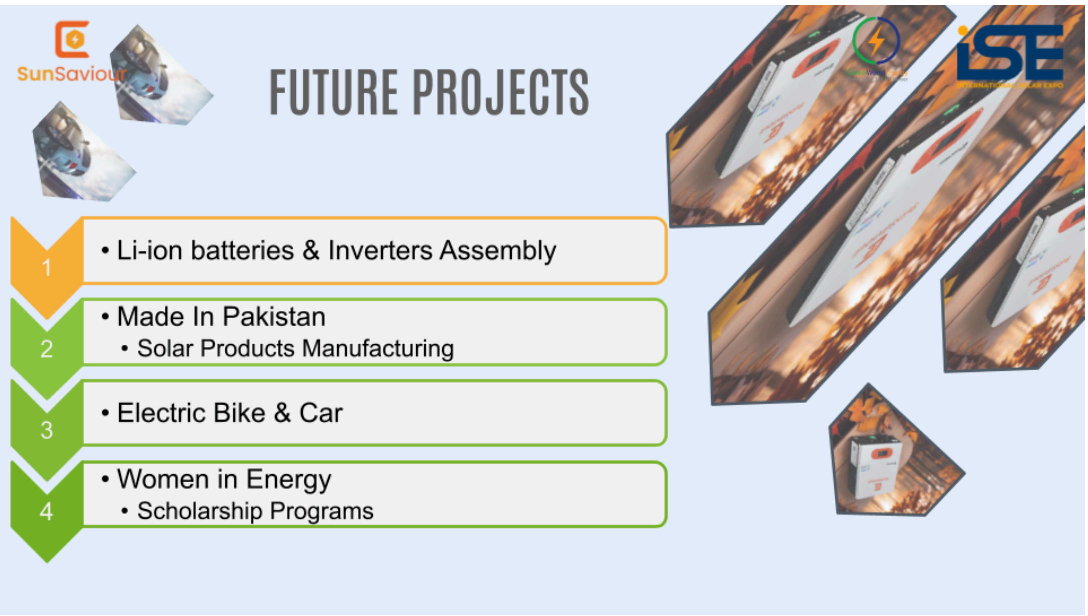
30 Million + Units Generated

20,000 Metric Tons CO_2 reduced

5,000 + Sites Solarized

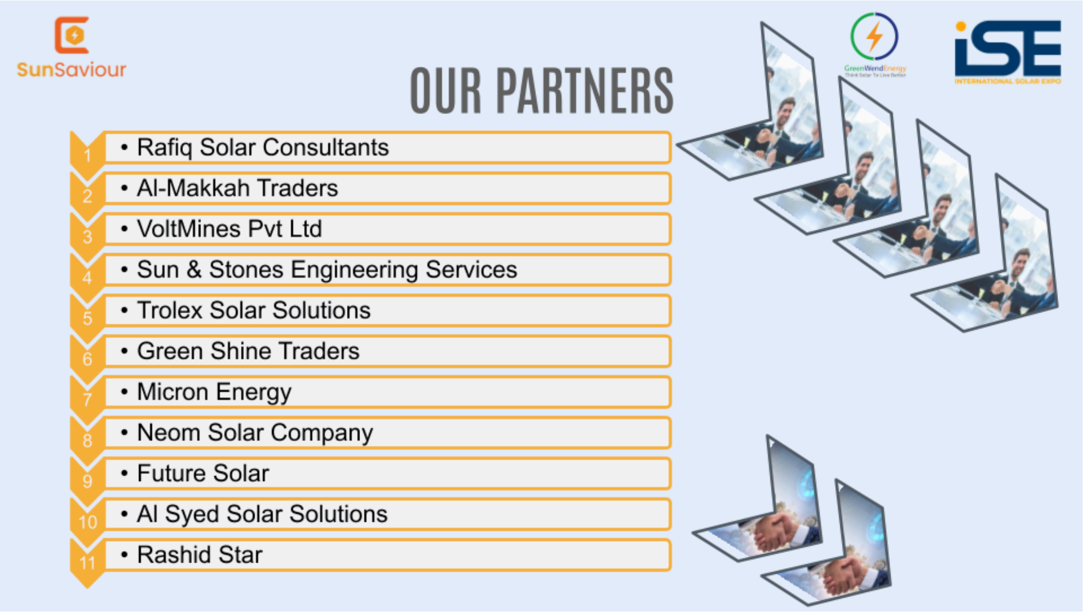
SunSaviour

FUTURE PROJECTS


SunSaviour
iSE

FUTURE PROJECTS

1. Li-ion batteries & Inverters Assembly
2. Made In Pakistan
   - Solar Products Manufacturing
3. Electric Bike & Car
4. Women in Energy
   - Scholarship Programs


SunSaviour
iSE

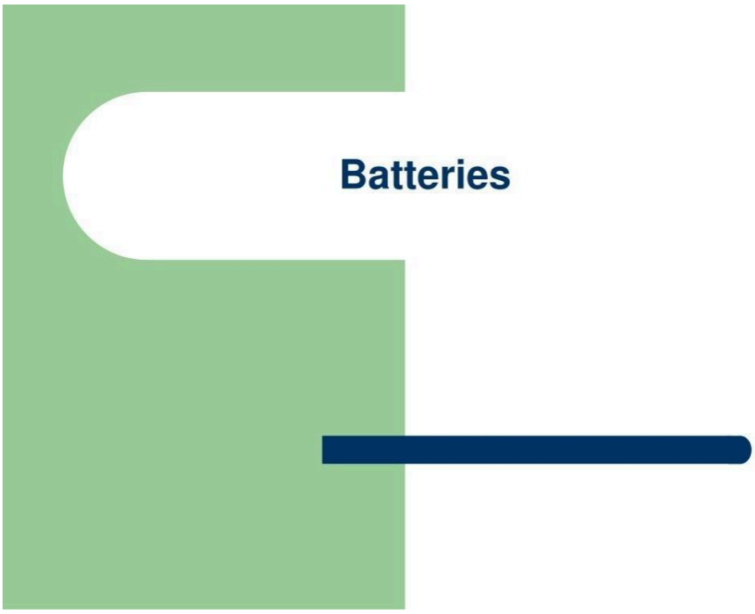
OUR PARTNERS

1. Rafiq Solar Consultants
2. Al-Makkah Traders
3. VoltMines Pvt Ltd
4. Sun & Stones Engineering Services
5. Trolex Solar Solutions
6. Green Shine Traders
7. Micron Energy
8. Neom Solar Company
9. Future Solar
10. Al Syed Solar Solutions
11. Rashid Star

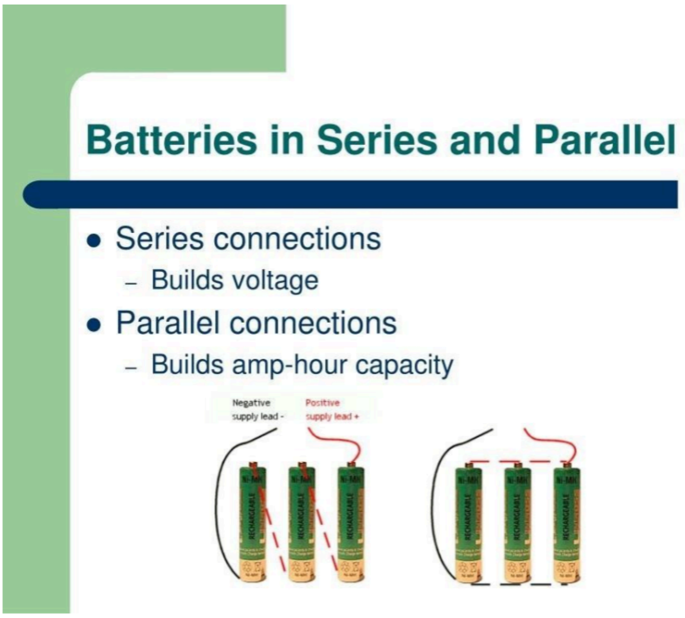
OUR TEAM

INVESTMENT OPPORTUNITIES

5. Dr Amjad Khattak, HOD, EE, UET, Peshawar



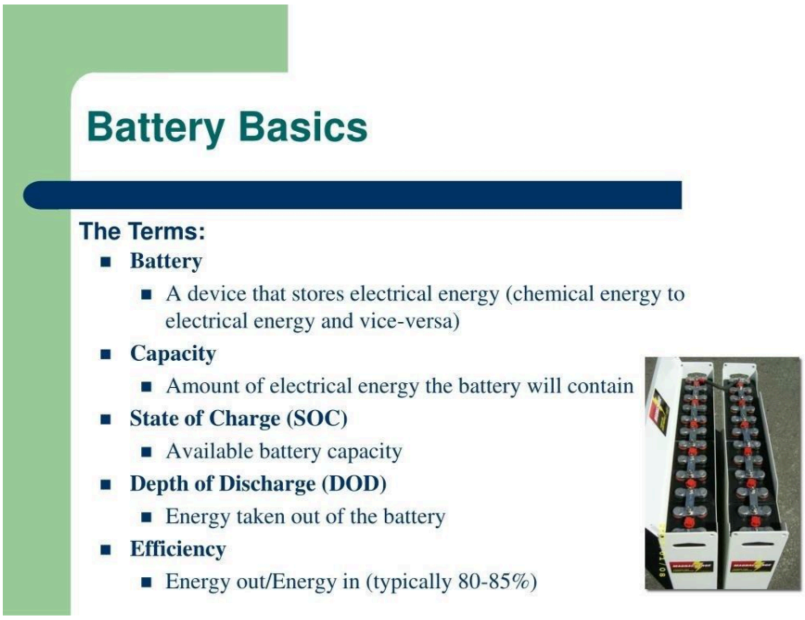
Batteries



Batteries in Series and Parallel

- Series connections
  - Builds voltage
- Parallel connections
  - Builds amp-hour capacity

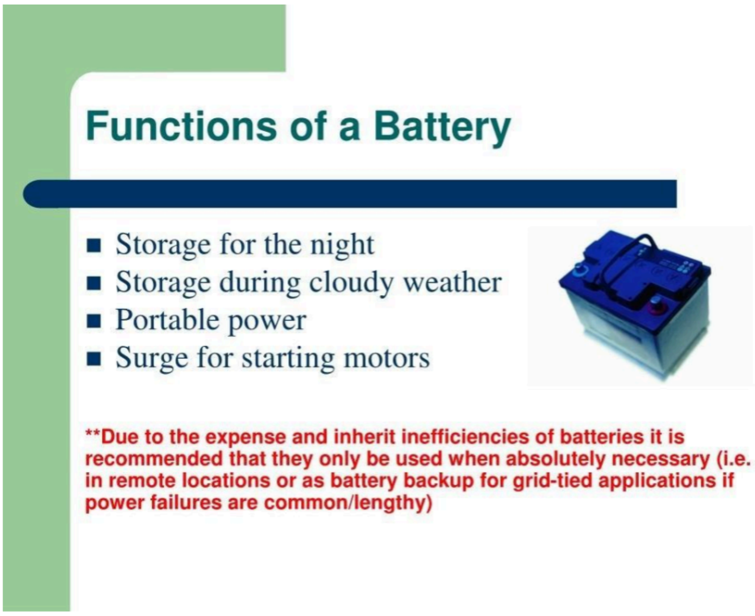
Negative supply lead -
Positive supply lead +



Battery Basics

The Terms:

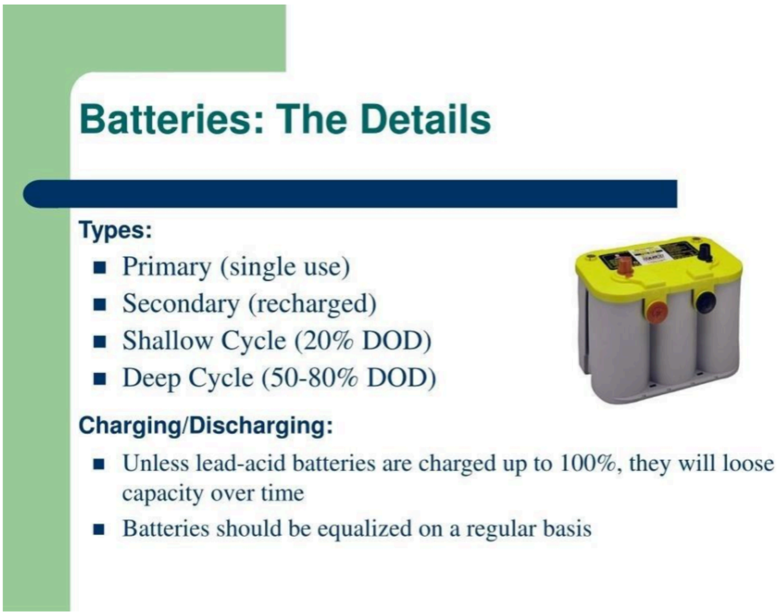
- **Battery**
  - A device that stores electrical energy (chemical energy to electrical energy and vice-versa)
- **Capacity**
  - Amount of electrical energy the battery will contain
- **State of Charge (SOC)**
  - Available battery capacity
- **Depth of Discharge (DOD)**
  - Energy taken out of the battery
- **Efficiency**
  - Energy out/Energy in (typically 80-85%)



Functions of a Battery

- Storage for the night
- Storage during cloudy weather
- Portable power
- Surge for starting motors

****Due to the expense and inherit inefficiencies of batteries it is recommended that they only be used when absolutely necessary (i.e. in remote locations or as battery backup for grid-tied applications if power failures are common/lengthy)**



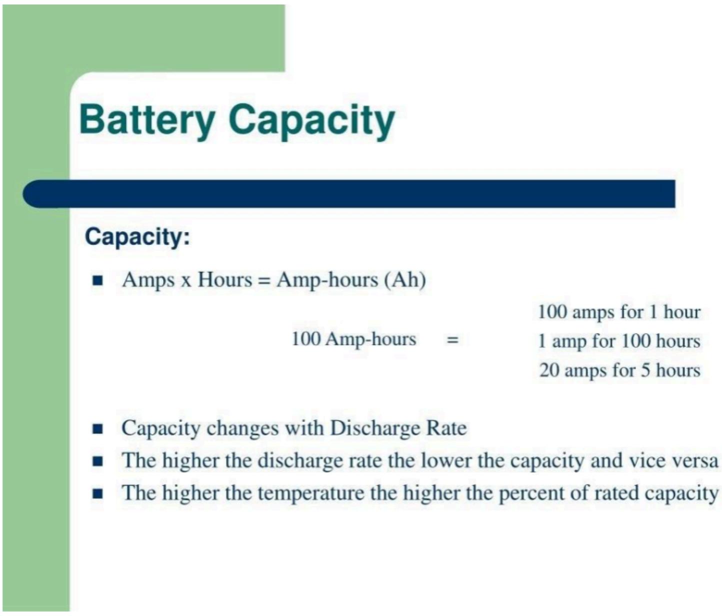
Batteries: The Details

Types:

- Primary (single use)
- Secondary (recharged)
- Shallow Cycle (20% DOD)
- Deep Cycle (50-80% DOD)

Charging/Discharging:

- Unless lead-acid batteries are charged up to 100%, they will loose capacity over time
- Batteries should be equalized on a regular basis



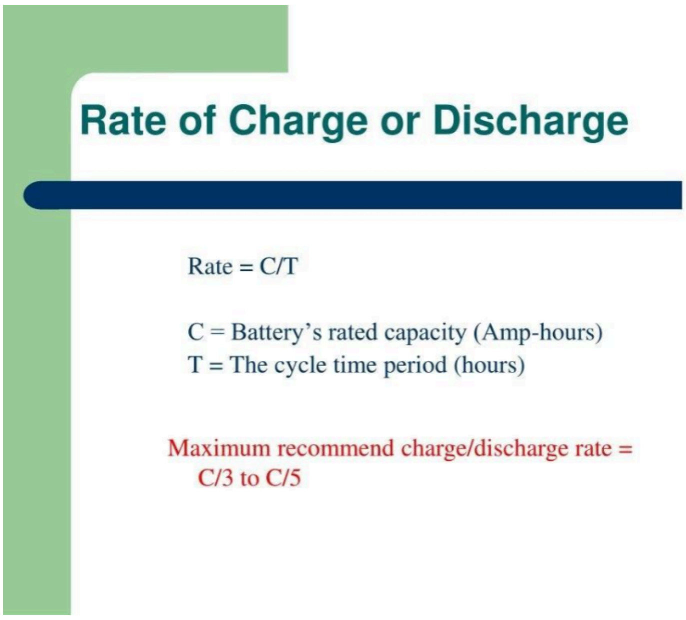
Battery Capacity

Capacity:

- Amps x Hours = Amp-hours (Ah)

100 Amp-hours =
100 amps for 1 hour
1 amp for 100 hours
20 amps for 5 hours

- Capacity changes with Discharge Rate
- The higher the discharge rate the lower the capacity and vice versa
- The higher the temperature the higher the percent of rated capacity

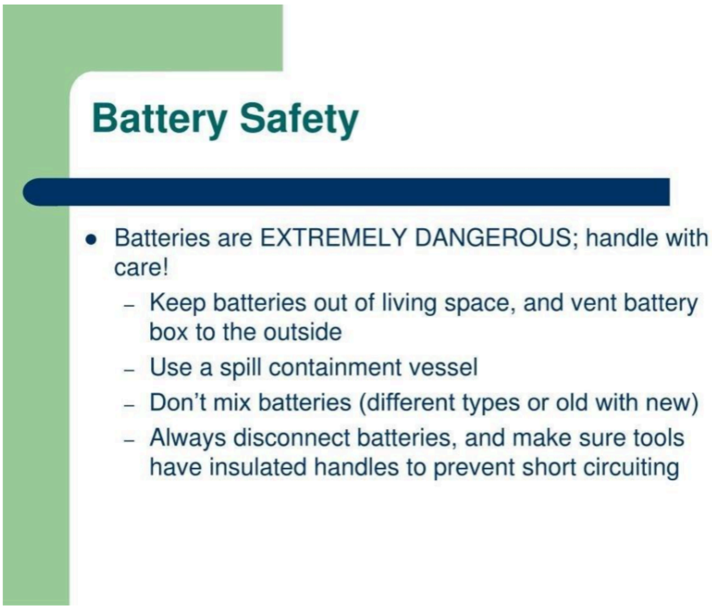


Rate of Charge or Discharge

Rate = C/T

C = Battery’s rated capacity (Amp-hours)
T = The cycle time period (hours)

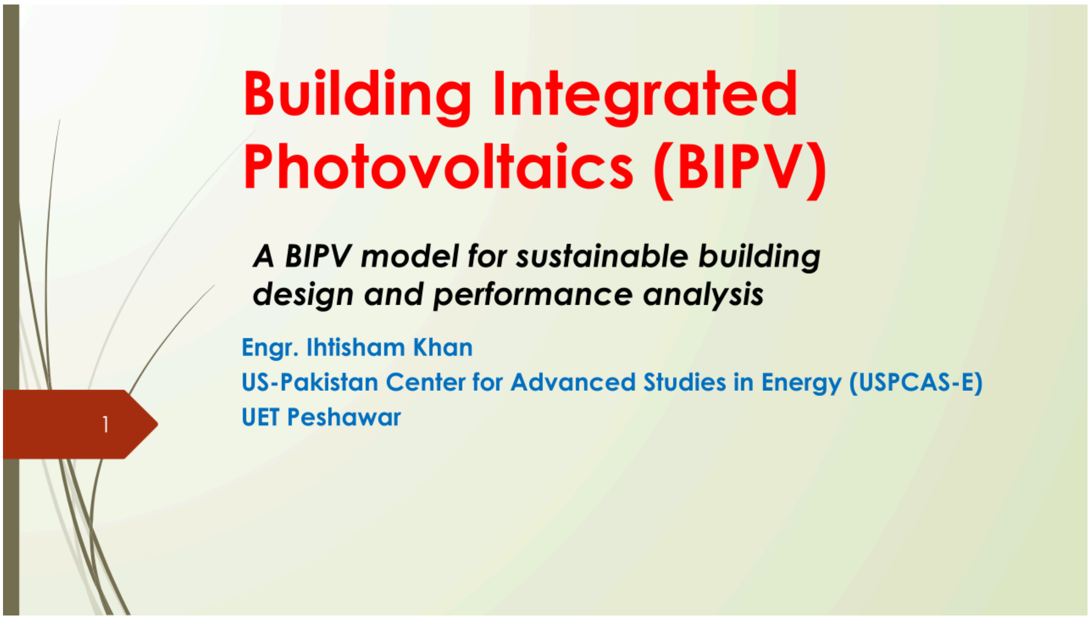
Maximum recommend charge/discharge rate = C/3 to C/5



Battery Safety

- Batteries are EXTREMELY DANGEROUS; handle with care!
  - Keep batteries out of living space, and vent battery box to the outside
  - Use a spill containment vessel
  - Don’t mix batteries (different types or old with new)
  - Always disconnect batteries, and make sure tools have insulated handles to prevent short circuiting

6. Engr. Ihtisham Khan, USPCAS-E, UET Peshawar

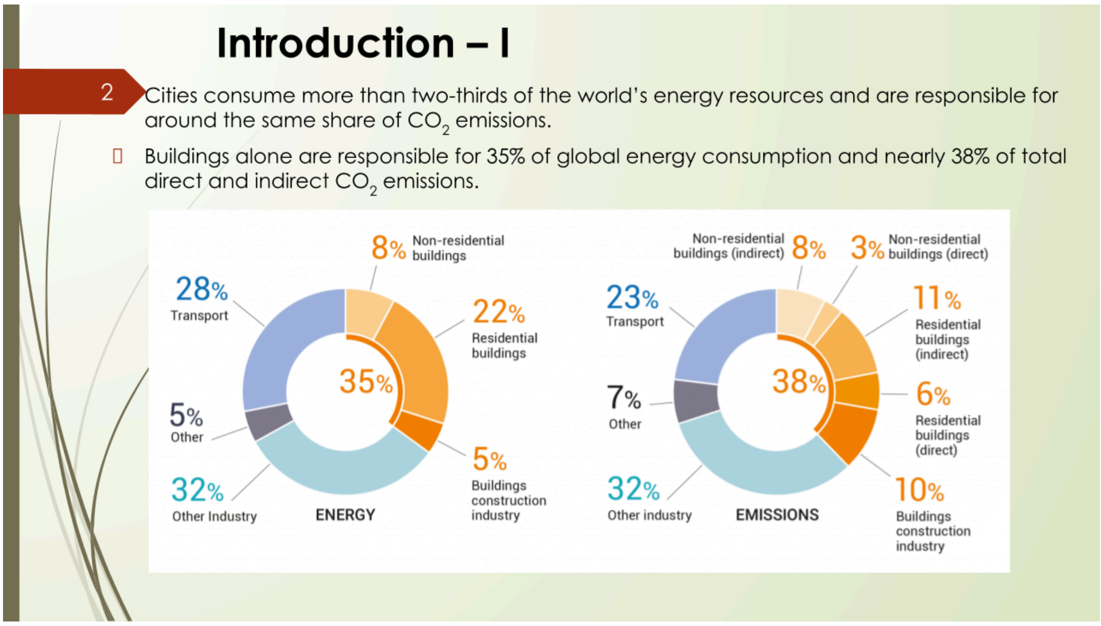


1

Building Integrated Photovoltaics (BIPV)

A BIPV model for sustainable building design and performance analysis

Engr. Ihtisham Khan
US-Pakistan Center for Advanced Studies in Energy (USPCAS-E)
UET Peshawar



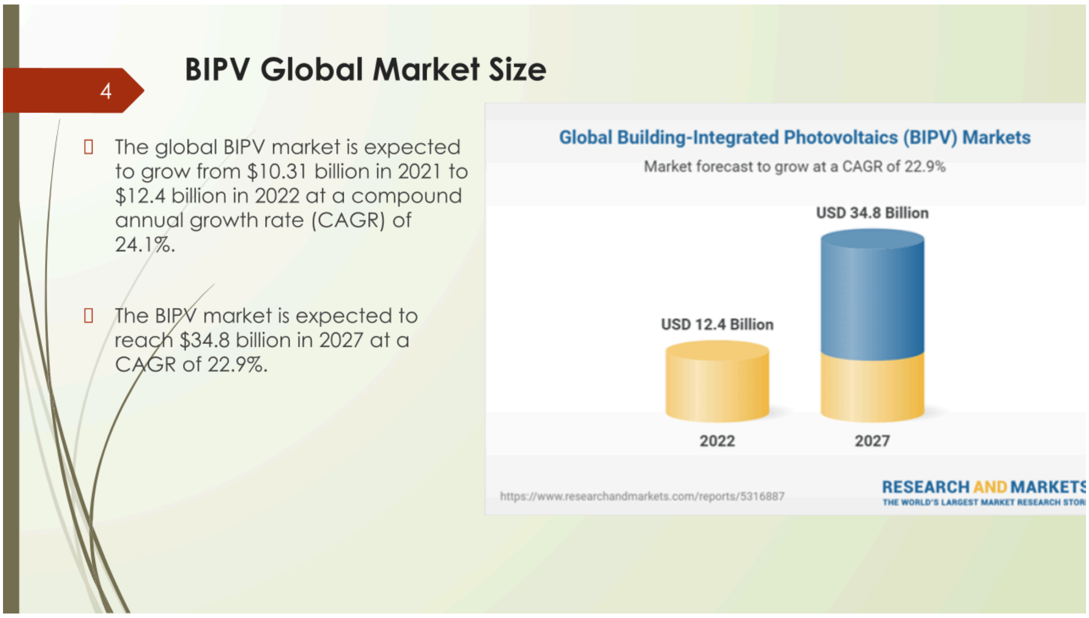
2

Introduction – I

- Cities consume more than two-thirds of the world's energy resources and are responsible for around the same share of CO_2 emissions.
- Buildings alone are responsible for 35% of global energy consumption and nearly 38% of total direct and indirect CO_2 emissions.

BIPV systems – I

- Building Integrated Photovoltaics (BIPV) integrates photovoltaic (PV) into the building envelope.
- Through this technology, facades, roofs, walls, corridors, canopies, and many such large and small spaces can be transformed into sources of electricity generation. Therefore, it is a space-saving technology.
- BIPV modules serve the dual function of building skin by replacing the conventional building envelope materials and power generation.
- Currently, there is a growing consensus that BIPV systems will be the backbone of zero energy building (ZEB).



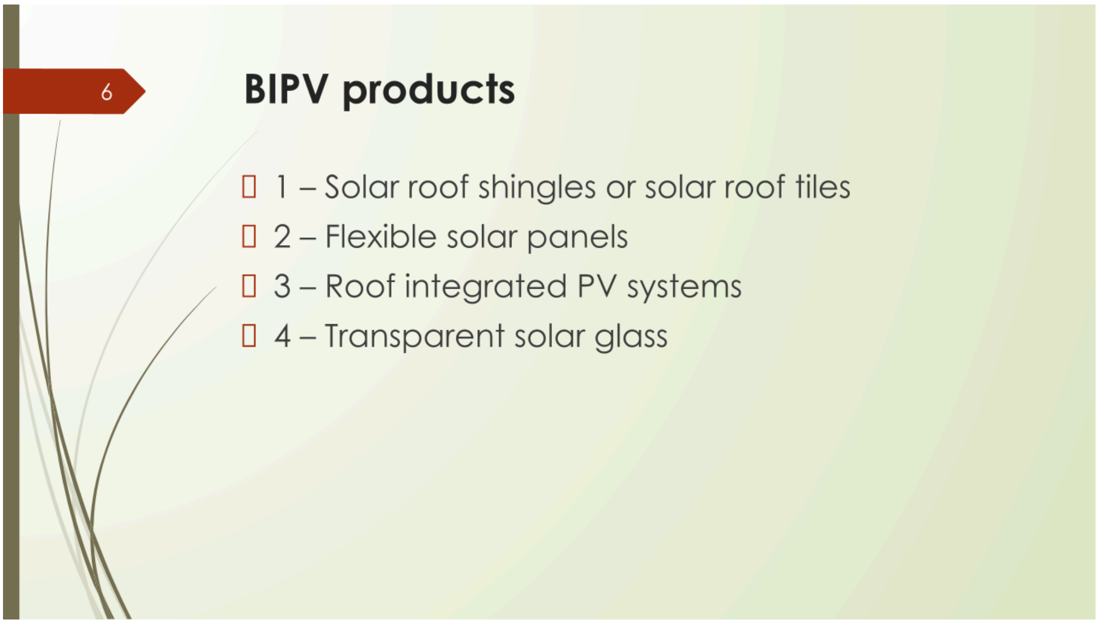
BIPV Global Market Size

- The global BIPV market is expected to grow from $10.31 billion in 2021 to $12.4 billion in 2022 at a compound annual growth rate (CAGR) of 24.1%.
- The BIPV market is expected to reach $34.8 billion in 2027 at a CAGR of 22.9%.

Global Building-Integrated Photovoltaics (BIPV) Markets

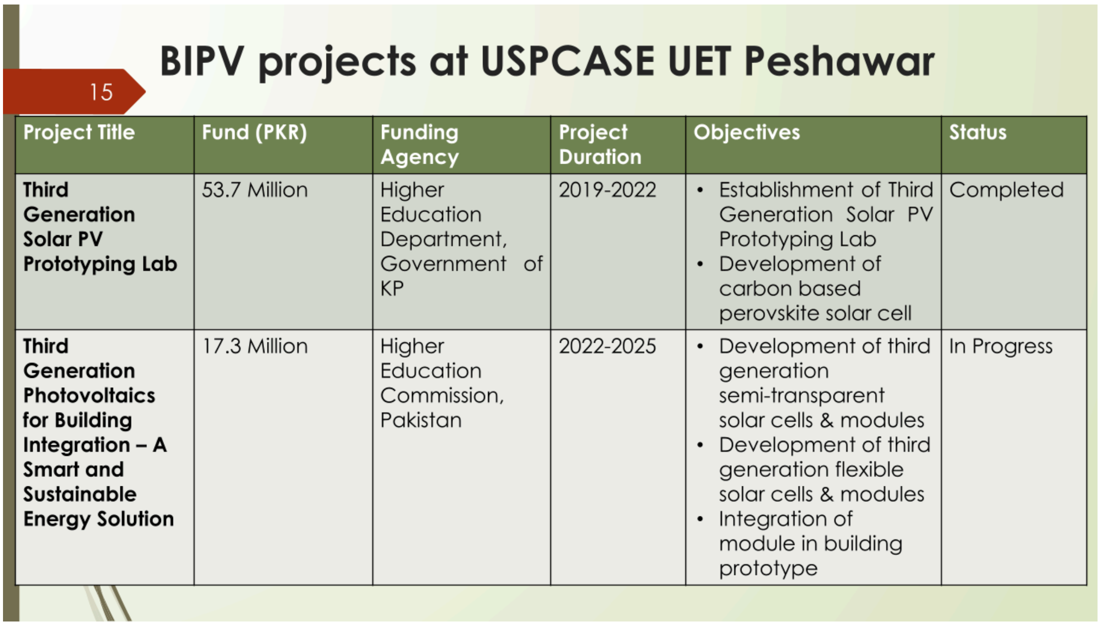
Market forecast to grow at a CAGR of 22.9%

https://www.researchandmarkets.com/reports/5316887



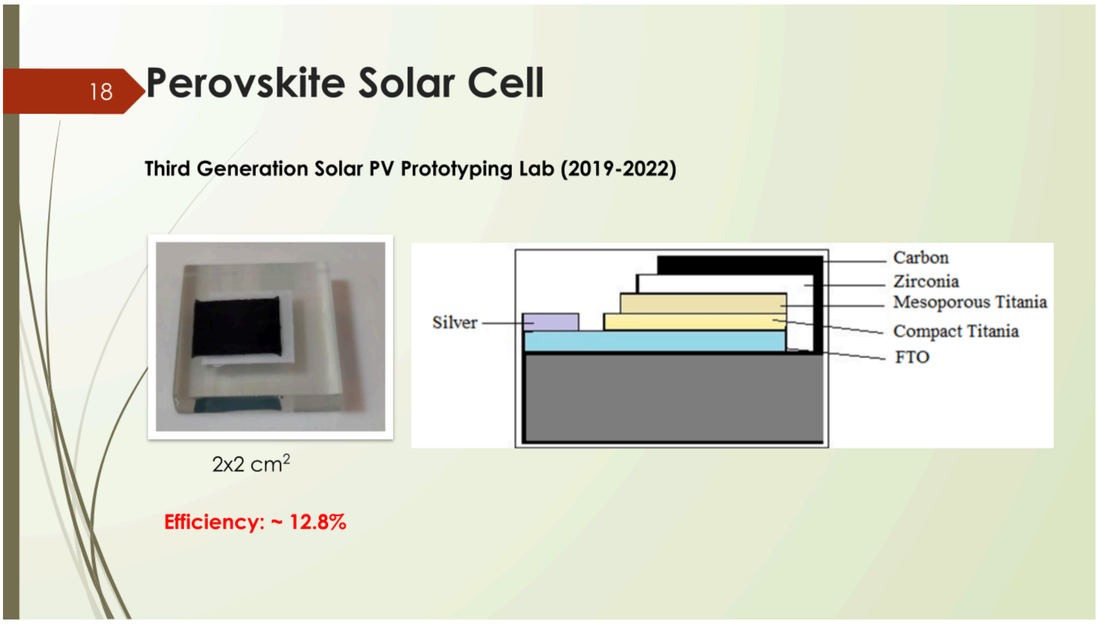
BIPV products

- 1 – Solar roof shingles or solar roof tiles
- 2 – Flexible solar panels
- 3 – Roof integrated PV systems
- 4 – Transparent solar glass



BIPV projects at USPCASE UET Peshawar

Project Title	Fund (PKR)	Funding Agency	Project Duration	Objectives	Status
Third Generation Solar PV Prototyping Lab	53.7 Million	Higher Education Department, Government of KP	2019-2022	• Establishment of Third Generation Solar PV Prototyping Lab • Development of carbon based perovskite solar cell	Completed
Third Generation Photovoltaics for Building Integration – A Smart and Sustainable Energy Solution	17.3 Million	Higher Education Commission, Pakistan	2022-2025	• Development of third generation semi-transparent solar cells & modules • Development of third generation flexible solar cells & modules • Integration of module in building prototype	In Progress



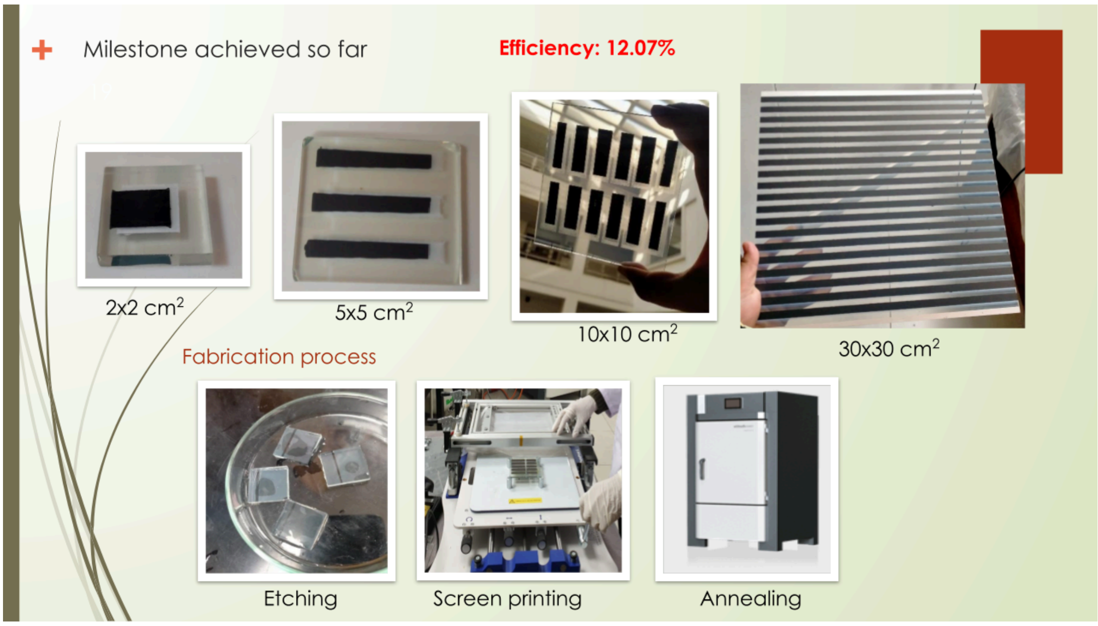
Perovskite Solar Cell

Third Generation Solar PV Prototyping Lab (2019-2022)

Silver
Carbon
Zirconia
Mesoporous Titania
Compact Titania
FTO

2x2 cm^2

Efficiency: ~ 12.8%



- Milestone achieved so far

Efficiency: 12.07%

2x2 cm^2

5x5 cm^2

10x10 cm^2

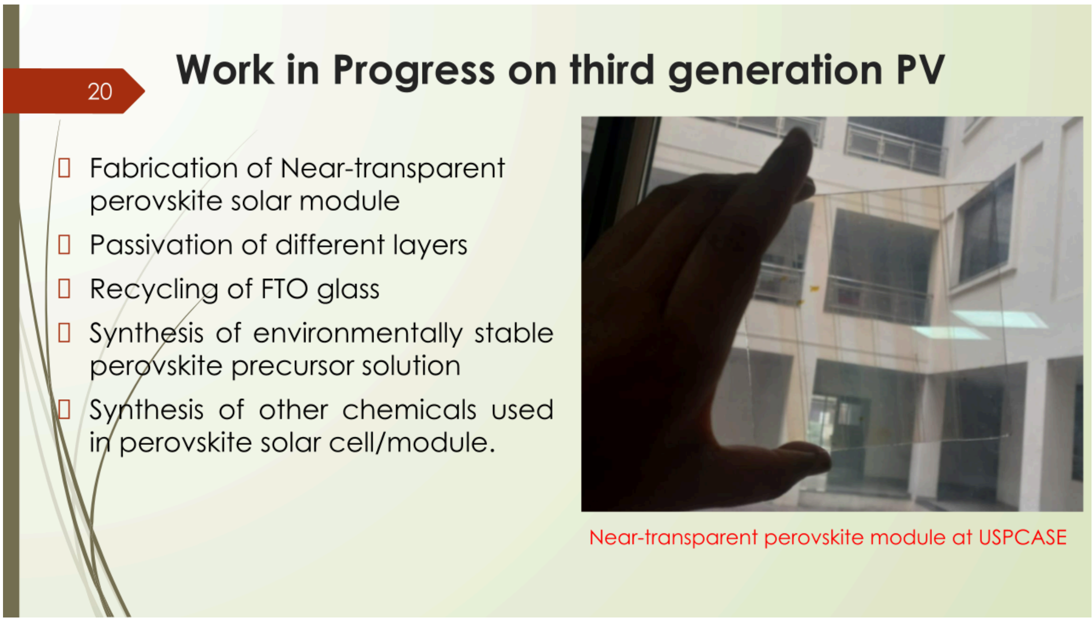
30x30 cm^2

Fabrication process

Etching

Screen printing

Annealing



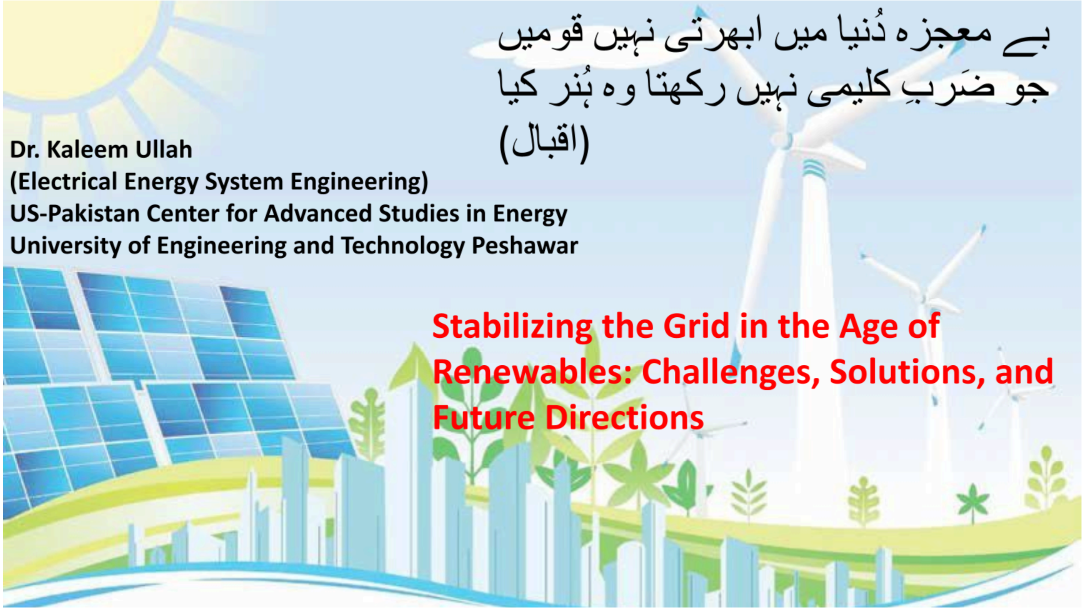
Work in Progress on third generation PV

- Fabrication of Near-transparent perovskite solar module
- Passivation of different layers
- Recycling of FTO glass
- Synthesis of environmentally stable perovskite precursor solution
- Synthesis of other chemicals used in perovskite solar cell/module.

Near-transparent perovskite module at USPCASE

Dr

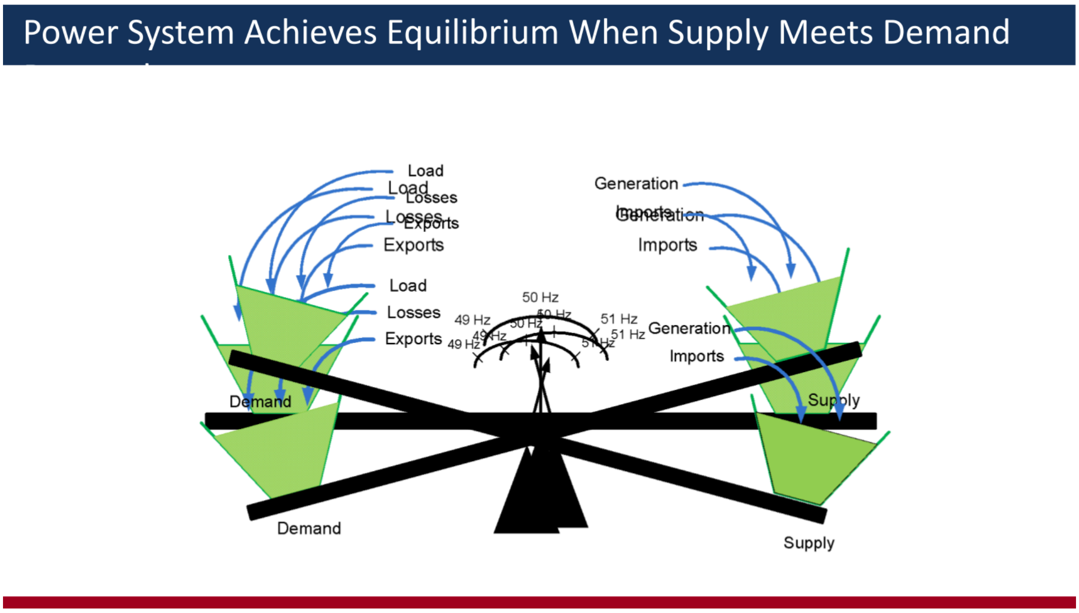
7. Dr Kaleemullah, EESE, USPCASE, UET, Peshawar



بے معجزہ دُنیا میں ابھرتی نہیں قومیں
جو ضَربِ کلیمی نہیں رکھتا وہ ہُنر کیا
(اقبال)

Dr. Kaleem Ullah
(Electrical Energy System Engineering)
US-Pakistan Center for Advanced Studies in Energy
University of Engineering and Technology Peshawar

Stabilizing the Grid in the Age of Renewables: Challenges, Solutions, and Future Directions



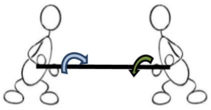
Power System Achieves Equilibrium When Supply Meets Demand

Frequency Basics

Inertia Response

The greater the inertia, the less will be the frequency deviation.

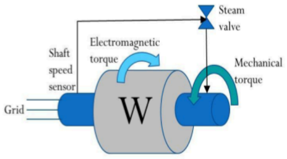
Inertia is proportional to the total rotating mass



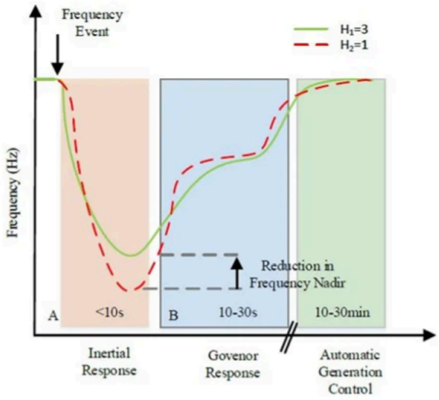
$$\frac{2H}{\omega_{\mathrm{Re}}}\dot{\omega}(t) = P_{au}$$

Primary Control

Senses shaft speed proportional to frequency and adjusts turbine mechanical power to respond to frequency deviations.



Secondary control: Provided manual or Through AGC/LFC

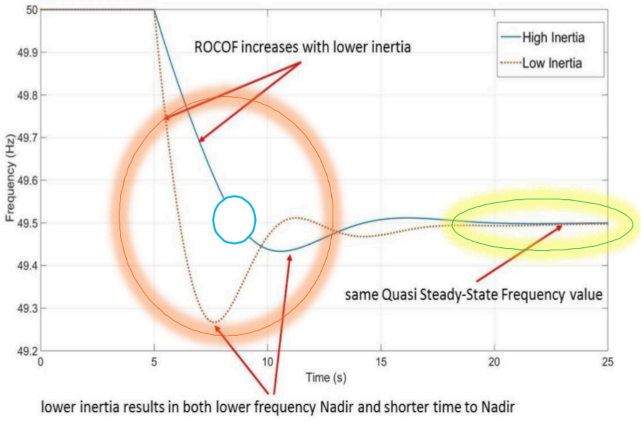


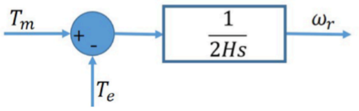
System Operation Challenges With Ultra-deep Penetration Of RES

Main Challenges

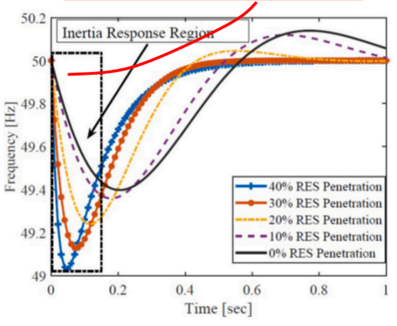
- Low-inertia operation
- Variability, uncertainty, balancing, and ramping requirements
- Minimum demand issues and system strength
- “Indistinct” events
- Under-frequency load shedding (UFLS) issues

Frequency Response challenges in low-inertia power systems





For Renewables, What will be the ROCOF Behavior ??



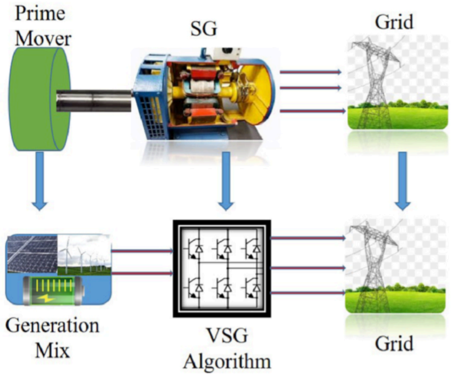
Impacts of penetration of RE sources to the system frequency response.

Dynamic requirements for frequency response increase

Solution for Renewables based Power Grids- Synthetic Inertia

- Synthetic inertia provides a critical solution to mitigate the challenges posed by high RE penetration
- The swing equation can be modified as:

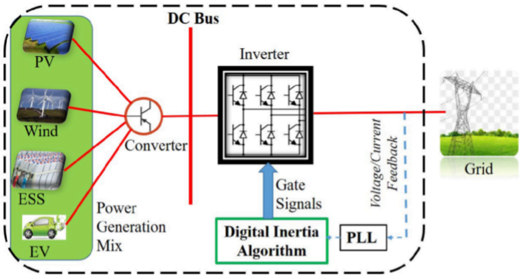
$$H_{eq} = \frac{\underbrace{\sum_{i=1}^{N} H_i \times S_{B,i}}_{H_S} + \underbrace{\sum_{j=1}^{V} H_{VI,j} \times S_{B,j}}_{H_{VI}}}{S_B}$$

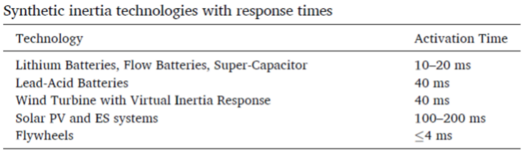


Synthetic inertia controls must preempt frequency extremes to prevent network instability.

Dynamic Vs Static Inertia

- Traditional power systems, inertia is a constant and predictable factor influencing frequency response.
- Dynamic inertia arises due to the extensive use of stochastic synthetic inertia to support frequency response.

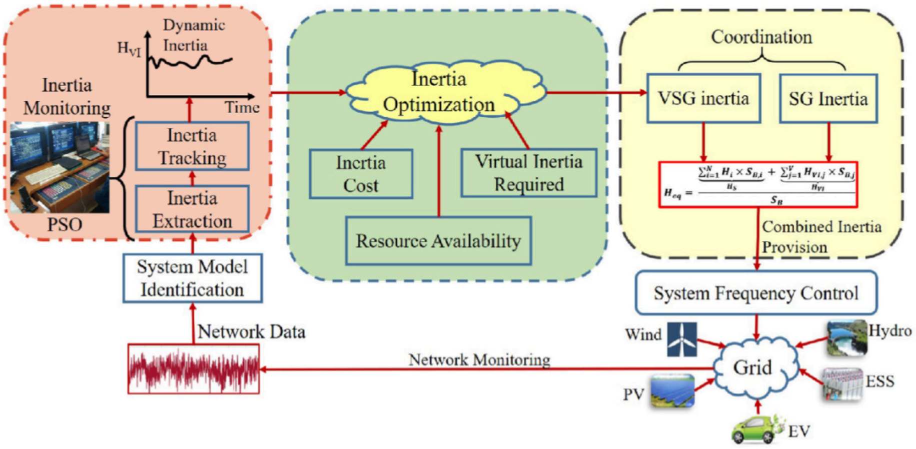




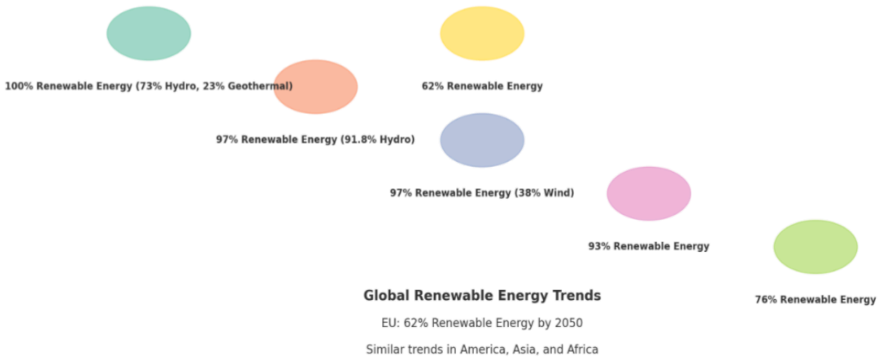
Synthetic inertia technologies with response times

Technology	Activation Time
Lithium Batteries, Flow Batteries, Super-Capacitor	10–20 ms
Lead-Acid Batteries	40 ms
Wind Turbine with Virtual Inertia Response	40 ms
Solar PV and ES systems	100–200 ms
Flywheels	≤4 ms

Synthetic Inertia based Power Grids



Towards 100 Percent Renewable Energy-Use of Synthetic Inertia



100% Renewable Energy (73% Hydro, 23% Geothermal)

62% Renewable Energy

97% Renewable Energy (91.8% Hydro)

97% Renewable Energy (38% Wind)

93% Renewable Energy

76% Renewable Energy

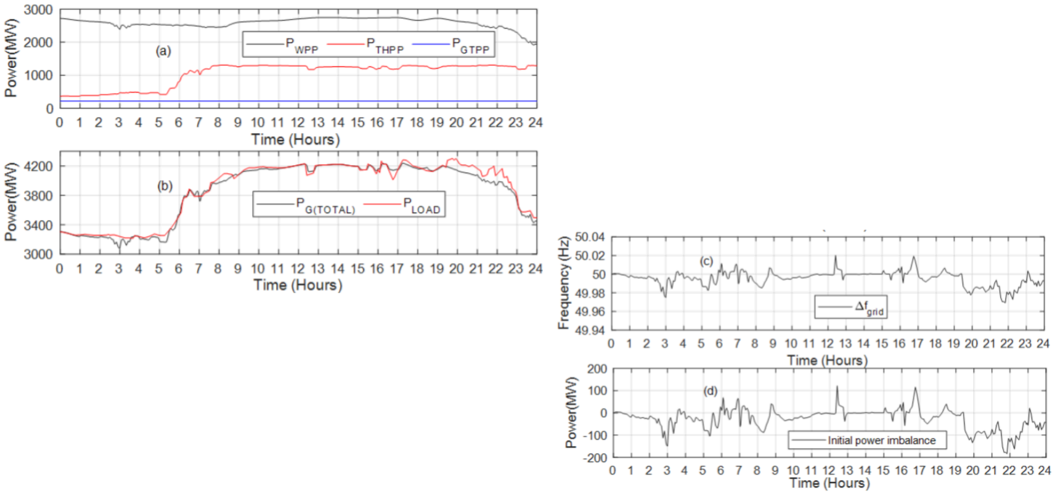
Global Renewable Energy Trends

EU: 62% Renewable Energy by 2050

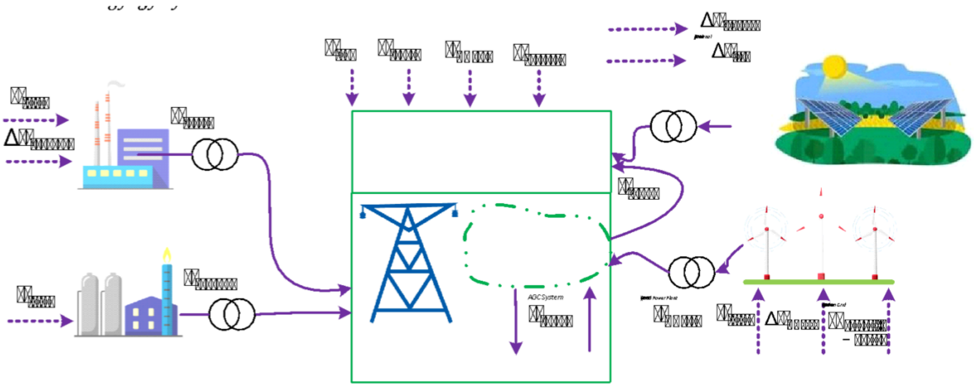
Similar trends in America, Asia, and Africa

- **Iceland:** 100% renewable energy (73% hydro, 23% geothermal)
- **Norway:** 97% renewable energy (91.8% hydro)
- **Uruguay:** 97% renewable energy (38% wind)
- **Costa Rica:** 93% renewable energy
- **Brazil:** 76% renewable energy
- **Canada:** 62% renewable energy

Solar Energy Systems- Impact of solar and wind Uncertainties



Solutions- Impact of solar and wind Uncertainties



Solar Energy Systems- For Solar Energy System –De-loading Strategy

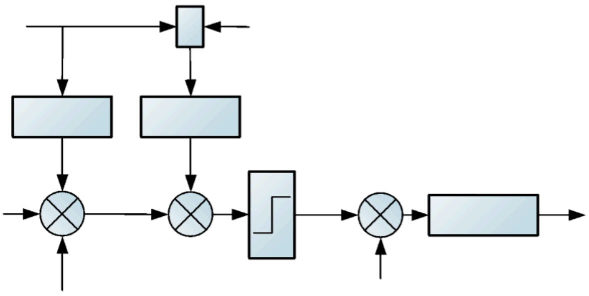


Figure 1(b) Modified de-loading strategy-based PV systems.

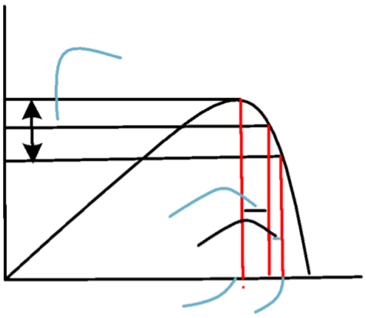


Figure 1(a): PV system regulation using de-loading strategy.

Research Abstracts

RA-1. Optimising Solar Panel Output with an AI-Driven Approach in Grid Station Design – Muhammad Khubaib, CECOS Peshawar

Abstract

Hotspots (HS) reduce the output power (P) of photovoltaic modules (PVMs) and sometimes lead to fires. However, it is difficult to effectively classify and detect HS faults. In this paper, we focus on the classification and detection of Shaded HS and Unshaded HS. HS faults not only occur due to non-uniform illumination and parameter mismatch but due to internal defects as well, such as; low resistance defects of a cell. The Shaded HS can be repaired sometimes by water washing, such as PVMs in the desert, while the Unshaded HS can only be repaired by replacing them. Therefore, to classify and detect such HS faults, we propose a fuzzy classification method based on data-driven rules learning. Firstly, the characteristic performances of Shaded and Unshaded HS PVMs are compared with the performances of normal PVMs. Secondly, the percentage reduction algorithm is presented for extracting three fault indicators to identify such HS faults. Then, a classification method is proposed using a technique called the Mamdani-type Fuzzy logic system, in which the rules are obtained by a process called the "Data-Driven Rule Generation Method". Finally, a low-resistance HS model is built using Matlab Simulink. The simulation and experiment results show that the proposed method has more classification accuracy for Shaded and Unshaded HS faults.

RA-2. Smart Solar PV Cleaning Robot – Muhammad Zubair and Shahid Alam; Department of Electrical Engineering, Sarhad University of Science & IT, Peshawar

Smart Solar PV Cleaning system includes a cleaning robot equipped with a rotating brush to remove dirt without using water or chemicals, which can move across the solar panels back and forth. The robot will be self-powered by solar energy and battery, will clean solar panels on a fixed given time. The robot will also have a Wi-Fi communication module from which we can customise the cleaning time using mobile APP. The robot will be able to increase the efficiency and output of the solar panels by up to 30% [1-3], depending on the dust conditions and the cleaning frequency.

The aim of this project is to design and implement an automated cleaning system for solar panels using a specific time and Wi-Fi data signals. The system consists of a cleaning device that moves along the solar panel array and operates a rotating brush to remove dust and dirt. The device is controlled by a microcontroller that uses time or receives Wi-Fi data from a smartphone APP. The APP allows the user to start and stop the cleaning process. The motor starts rotating the brush and cleaning the module. The microcontroller will check for edges using ultrasonic sensors. When the edge is detected the robot will go back to initial position. After reaching the initial position the rotation of the brush will also be stopped. We will design a mobile App that allows users to start or stop the cleaning process and customise the cleaning time. It will also store data of both solar panels, with and without the proposed robot for our analysis portion. We will test and analyse our project by comparing it with a solar panel without cleaning robot for a period of six months.

Applications/Features include: i) Smart solar panel cleaning robot (SPCR) maintains solar energy systems, maximising output and efficiency; ii) Cost-effective cleaning reduces manual labour and attracts solar power plant operators; iii) SPCR's automation enhances efficiency, allowing for systematic cleaning of large arrays; iii) SPCR represents ongoing research in solar energy technology and automation; iv) SPCR drives innovation in automated cleaning systems for solar panels; v) The robot can be used to clean large-scale solar installations in remote and dusty areas, where manual cleaning is costly and inefficient.

RA-3. Synthesis and Characterization of Tin dioxide (SnO_2) Electron Transport Layer for Next Generation Flexible Solar Cells and Modules - Noor us Saba, Muhammad Saad Rehan, Zia Ullah, Adnan Daud Khan, Muhammad Noman; Shaheed Benazir Bhutto Women University, Peshawar

The electron transport layer (ETL) is one of the significant charge transport layers in the perovskite solar cells (PSCs). Tin dioxide (SnO_2) demonstrates exceptional potential as an electron transport layer (ETL) in low-temperature processed perovskite solar cells, offering high electron mobility and compatibility with the flexible substrates. In this work, we report an easy and cost-effective method for synthesis of SnO2 colloidal dispersion through a refluxing process at 85^oC for three hours. The synthesis was followed by deposition of SnO_2 on glass substrates through spin coating. The deposited layers were tested for structural and optical properties using X-ray Diffractometer and Spectrophotometer. The high intensity diffraction peaks at 29^o confirm the crystalline structure of the synthesised ETL. Further, the transmittance of around 90% in the visible range (400-800 nm) clearly depicts satisfactory optical performance. The significance of this work lies in the fact that SnO_2 has been synthesised at temperature below 200^oC, thus can lead to the development of next generation flexible solar cells and modules.

RA4. Harnessing Solar Energy for Public Health: A Clean and Sustainable Solution - Urooj Khan, 3 rd Year MBBS, Khyber Medical College Peshawar

ABSTRACT

Solar energy emerges as a pivotal force in enhancing public health and advancing United NationsSustainable Development Goals (SDGs). Unlike fossil fuels such as coal, oil, and natural gas, solar energy stands as a clean and renewable alternative that safeguards both human health and the environment. This exploration underscores the profound impact of solar energy on public health compared to dirty energy sources, offering a sustainable and equitable solution to mitigate their harmful effects. By transitioning to solar energy, we not only protect public health but also contribute to achieving SDGs like Goal 3 (Good Health and Well-being) by mitigating health risks associated with dirty energy. Additionally, solar

energy's alignment with Goal 7 (Affordable and Clean Energy) ensures equitable access to clean energy, fostering healthier communities and supporting Goal 11 (Sustainable Cities and Communities). Furthermore, its role in reducing greenhouse gas emissions contributes to Goal 13 (Climate Action) while minimising land degradation, thereby supporting Goal 15 (Life on Land). Ultimately, embracing solar energy heralds a transformative journey towards sustainable development, promoting public health, and nurturing resilient communities for generations to come.

RA5. Conversion Kit for E-bike; Muhammad Umar Khan 6th Semester Electrical Engineering Department UET Peshawar (Jalozai Campus)

Abstract:

The rising popularity of electric bikes (e-bikes) has prompted many enthusiasts to explore ways to convert their traditional motorbikes into electrically powered counterparts. My idea introduces a comprehensive conversion kit designed to facilitate this transition seamlessly. The kit includes essential components such as a motor, battery, controller, sensors, and detailed installation instructions. Key features of the conversion kit include versatility to fit various bike models, compatibility with different wheel sizes, and customizable power settings to suit individual preferences. Additionally, the kit prioritises safety through robust construction and adherence to industry standards. Through this abstract, we provide an overview of the Conversion Kit for E-bike, highlighting its potential to empower cyclists to embrace the advantages of electric propulsion while retaining the familiarity and comfort of their existing Motorbikes.

RA6. AI Support: Sustainable Future in Renewable Energy; Shabhi Haider, Renewable Energy, Iqra University; shabhihaider@gmail.com

The transition to renewable energy sources is crucial for mitigating climate change, but integrating intermittent sources like solar and wind power into existing grids poses significant challenges. AI and big data analytics offer powerful tools to address these challenges, enabling more efficient and reliable energy systems. This study aims to explore the potential of AI and big data in optimising renewable energy generation, distribution, and consumption. Specifically, we investigate how these technologies can improve forecasting accuracy, facilitate real-time grid management, and enhance predictive maintenance of renewable energy infrastructure. I conducted a comprehensive literature review of existing research on AI and big data applications in the renewable energy sector. I analysed case studies of successful implementations, focusing on areas like solar energy forecasting, demand management, and grid integration.

The analysis reveals that AI algorithms, particularly machine learning and deep learning techniques, demonstrate significant potential in improving the accuracy of renewable energy forecasting. Big data analytics enables real-time monitoring of grid performance and facilitates dynamic load balancing, optimising energy distribution. Furthermore, AI-powered predictive maintenance systems can identify potential equipment failures before they occur, reducing downtime and maintenance costs. It can be concluded that AI and big data are essential tools for optimising renewable energy systems, paving the way for a more sustainable future. These technologies can enhance grid stability, improve energy efficiency, and reduce costs associated with renewable energy deployment. Future research should focus on developing more sophisticated AI models tailored to specific renewable energy applications, exploring the potential of AI-driven energy trading platforms, and investigating the ethical and societal implications of these technologies.

RA7. Improving Performance in Lithium-Sulphur Batteries through Enhanced Cathode Conductivity - Waleed Jan, Adnan Daud Khan; U.S-Pakistan Center for Advanced Studies in Energy, University of Engineering & Technology, Peshawar; adnan.daud@uetpeshawar.edu.pk

ABSTRACT

The need for electrical energy storage devices has increased substantially as a result of recent technological developments. These devices can be used for a variety of operations, from large-scale grid energy storage systems to powering portable electronics like laptops and smartphones. Lithium-ion batteries (LiBs) are commonly utilised as energy storage systems and are prominent in the battery sector owing to their superior energy density compared to traditional systems, extended cycle life, and higher power density. Despite these advantages, LiBs encounter challenges in sustaining their energy density as they approach their practical limit. This presents a hurdle for their integration into Electric Vehicles (EVs) aiming for extensive driving ranges, as well as other modern electronic devices. The Lithium-sulphur Battery (LiSB) is gaining recognition as a notable alternative, drawing interest for advanced energy storage systems because of its exceptional characteristics. With its impressive specific capacity (1675 mAh/g), notable energy density (2600 Wh/kg), and the widespread availability of sulphur in nature, LiSBs show considerable potential as an upcoming high-energy storage solution. However, challenges such as poor conductivity of sulphur and polysulfide dissolution impede their practical application. This research focuses on the latest advancements in improving conductivity for LiSBs, with a particular emphasis on the role of novel nano-composite cathode materials such as sulphur/carbon nano-composite. This nano-composite material has gained significant attention due to its high conductivity at both ambient and high temperatures, good mechanical strength, and ability to suppress the dissolution of polysulfides. Furthermore, the potential benefits of LiSBs for the solar photovoltaic (PV) industry are also discussed. The high energy density and low cost of LiSBs make them an attractive option for energy storage in solar PV systems, which often suffer from intermittent power generation due to the variability of sunlight. By storing excess solar energy during peak sunlight hours and releasing it during periods of low sunlight or power outages, LiSBs can help to ensure a stable and continuous power supply, thereby enhancing the overall efficiency and economic viability of solar PV systems.

RA8. Influence of Band Alignment, Electric Field, Layer Thickness, Temperature, Series Resistance, and Shunt Resistance on Lead-Free Double Perovskite Solar Cells with Spiro-OMeTAD: A SCAPS-1D Simulation Study - Imama Ibrar, T.A. Qasuria, Zafir Salah Ud Din, and Malik Raed Zamindar; Faculty of Engineering Sciences, GIK Institute of Engineering Sciences and Technology, Pakistan; e-mail: imamaibrar@gmail.com

Abstract. Investigating the photovoltaic (PV) performance of lead-free double perovskite solar cells (DPSCs) with a structure comprising a fluorine-doped tin oxide (FTO) substrate, tungsten disulfide (WS_2) as the electron transport layer (ETL), inorganic-lead free and non-toxic double perovskite La_2NiMnO_6 absorber, Spiro-OMeTAD as the hole transport layer (HTL), and gold (Au) electrode using the SCAPS-1D framework is crucial for optimising their efficiency. Despite significant progress in DPSCs, there remains a research gap in understanding the fundamental mechanisms underlying their performance, particularly in optimising material properties and device architectures for enhanced efficiency. This study focuses on optimising the device architecture by investigating the impact of band alignment, electric field, layer thickness, temperature, series resistance, and shunt resistance on enhancing DPSC performance. Achieving an power conversion efficiency (PCE) of 18.51% with detailed analysis of the DPSCs highlights the key factors influencing their efficiency. These findings contribute valuable insights into enhancing the performance of DPSCs, advancing their potential for widespread adoption in solar energy conversion.

RA9. GREENWEND ENERGY SMART METER – The bidirectional metre for intelligent energy management; Muhammad Rovaid, Saad Rashid, Zeeshan Saeed Shah, Samia Subhan Qureshi, Hamna Raziq, Irfanul Haq Qureshi; GrweenWend Energy Pvt Ltd, Peshawar

Abstract

Smart Energy Meter (SEM) addresses the growing demand for sophisticated monitoring systems in the face of global efforts towards sustainable energy solutions. It builds upon the initial concept designed for single-phase systems, adapting it to the variation of three-phase setups. The system calculates real-time solar generation, imports and exports units, individual phase consumption, currents, power factor, frequency, graphs consumption generation and generates comprehensive daily and weekly reports. The integration with a user-friendly mobile application enhances accessibility and control for users. SEM is equipped with high-precision sensors to measure import units, export units, units generated, voltages, currents, power, power factor, frequency, and home usage. The device can estimate the cost of using grid and solar energy, providing consumers with a clear understanding of their energy consumption costs. SEM Provides accurate measurement of energy consumption and generation for solar installations. Supports both single-phase and three-phase supply. It provides a clear overview of power consumption in GreenWend Energy App. Estimation of the cost of using grid and solar energy is made. SEM is a user-friendly interface for effortless operation. It provides high precision and accuracy in measurement.

RA10. Optimising Solar-integrated Smart Home Automation for Energy Efficiency and Sustainability – Saad Rasheed, Muhammad Rovaid, Jalal Khan, Zeeshan Saeed Shah and Samia Subhan Qureshi, Hamna Raziq, Irfanul Haq Qureshi; Renewable Energy, USPCASE UET/GreenWend Energy/SunSaviour Pakistan, Peshawar

Abstract

The project aims to optimise energy consumption by utilising solar power and implementing intelligent automation in a home setting. By following the provided logic, the system effectively manages the distribution of power based on the availability of solar energy and the power requirements of different devices.

The integration of solar power allows for the utilisation of clean and renewable energy, reducing dependence on traditional electricity sources. The system constantly monitors the solar power input and compares it with the total AC power required by various servers in the home. If the solar power generated is equal to or greater than the total AC power demand, the system intelligently switches off unnecessary devices and turns on energy-efficient modes to maximise the utilisation of solar energy. This results in efficient use of available renewable energy resources, reducing reliance on the grid and minimising carbon footprint. In scenarios where solar power falls short of the total AC power demand, the system prioritises power distribution based on predefined conditions. By selectively turning off non-critical devices or redistributing power between servers, the system optimises energy allocation and ensures the most efficient use of available resources. Additionally, the system incorporates battery backup functionality to maintain uninterrupted power supply during periods of no solar power generation. By actively managing battery levels based on percentage thresholds, the system further ensures efficient utilisation of stored energy.

By combining solar power integration, intelligent automation, and effective power management strategies, the project demonstrates how smart home systems can contribute to energy efficiency, sustainability, and reduced reliance on conventional power sources.

SunSaviour	GreenWendEnergy Think Solar To Live Better	DAIRY SCIENCE PARK dsp	iSE INTERNATIONAL SOLAR EXPO
Har Ghar Ka Asli Player	**Think Solar to Live Better**	**Triple Helix Good Governance Model**	**Innovations for a Sustainable Future**

First International Solar Expo and Conference, June 1-2, 2024

The First International Solar Expo and Conference #ISE2024 was held on June 1-2, 2024. The Event was attended by delegates from the industry, civil society, academia and government organisations. The Event was organised by Prof M Subhan Qureshi, Chief Patron, Engr Zeeshan Saeed Shah CEO, Engr Saad Rashid CTO, Engr Irfan ul Haq Qureshi Coordinator General, senior staff of SunSaviour and Volunteers.

Industrial products, services and academic contributions were displayed through 30 stalls by private companies and universities. Three Panel Discussions were held, participated by 22 senior academicians and industry leaders. Keynote lectures were delivered by 7 notable leaders from academia and industry. Ten postgraduate scholars and researchers presented their research findings and ideas through powerpoint while 20 posters were presented by young scholars. Three top presenters were awarded cash prizes of Rs.50,000, Rs.30,000 and Rs.15,000, respectively. All the delegates were provided certificates of attendance on request.

Mr Ghulam Ali, Ex-Governor KP inaugurated the Event as the Chief Guest. He compared the status of Kashgar and Peshawar during meetings of the respective Mayors during 1983 and highlighted the tremendous potential of development for this region. The current event was the best model of engaging the educated youth in productive activities. GreenWend Energy was demonstrated as the best startup model in delivering solar energy services to the residential and commercial entities. Its products wing, the SunSaviour developed advanced versions of the inverters and lithium ion batteries, produced the same in Chinese factories and marketed in Pakistan with higher acceptance levels of the consumers. Best option for our youth would be to launch their solar energy related business setups for overcoming the energy, employment, environmental and financial crisis prevailing in the country.

President, Sarhad Chamber of Commerce and Industry (SCCI), Mr Fuad Ishaq chaired the Concluding Session. The President SCCI urged the government to take steps to promote the solar and green energy sector, which is the only way to fulfil the growing energy needs of the country that will not only provide a clean environment but also create employment opportunities. Keeping in the prevailing scenario, the SCCI chief identified solar energy as the only path to overcome the increasing energy crisis and needed to encourage this important sector at governmental level. He agreed on the Recommendations presented by Prof M Subhan Qureshi, Chief Patron ISE2024 and establishment of a Steering Committee on Solar Energy to oversee the issues faced by the to: 1) oversee the issues faced by the stakeholders; 2) facilitate the ongoing university graduates to establish entrepreneurship models and; 3) to work on reducing the burden on public treasury through solarization of the state owned entities like universities, schools, colleges, offices, tubewells, etc.

Recommendations

Based upon the advice of the Chief Guest of the Inaugural Session, Haji Ghulam Ali, Ex-Governor Khyber Pakhtunkhwa and Ex.Member Senate of Pakistan and Chairperson of the Senate Committee on Commerce and Textile Industry; advice of the Chief Guest of the Concluding Session, opinion of the members of the Panel Discussions and the Audience, the following recommendations are presented:

1. The recent bloom in the solar industry through investment of private sector and the residential and commercial consumers have resulted in expansion of the volume of business several folds (1.41 GW in 2024), but rumours of unjustified taxing of the consumers instead of incentivizing it, is resulting in an unrest among the people. A duty of about 40-50% has been imposed on import of inverters and lithium batteries, which is strange as the solar panels have been exempted from such duties. Hence, we recommend that Solar Energy Applications must be taken as a higher priority policy item at federal and provincial levels through legislative, administrative and financial coverage.
2. The practice of approval of the green energy metres for the solar systems installed in the province is troublesome for the consumers as it takes a very long time and passess through many hands expecting illegal favours. An transparent, user-friendly, online system may be introduced for allotment of greenwend energy metres to the consumers after uploading the essential document and the government approved fees.
3. The outgoing graduates from the universities would be facilitated in establishing solar based business setups in manufacturing, marketing or service delivery. ORIC offices of the Universities would be tasked to oversee such activities in coordination with the local and international solar companies, investors and donor agencies through an appropriate Endowment Fund not less than Rs.2 billion to be managed jointly by a 15- members Steering Committee of the private and public sector organisations, hosted by SCCI. Successful models like Inverex, GreenWend Energy, SunSaviour, Sky Electric, Tesla Pakistan would support the Committee in identifying startup models.
4. Financial Institutions would provide access to easy finance for such startups. The State Bank of Pakistan and Bank of Khyber would allocate special packages for supporting this initiative.
5. Manufacturing solar energy devices within the country and through joint ventures abroad, must be supported through an incentive package, covering regulatory, financial and marketing aspects, as an import substitution measure.
6. A special package may be provided for solarizing of the vulnerable families and individuals and houses located in the remote regions, with meagre power consumption, through reduced costing.
7. The Solar Energy sector may be provided legislative cover, not to be affected by political disturbances.
8. Bureaucratic hurdles usually hinder the development process in the country in spite of a strong political will for change; which needs to be overcome through legislation.

9. Universities may introduce postgraduate training and degree programs in designing, manufacturing, marketing and entrepreneurship development.
10. Food Security may be ensured through Solar Energy Applications like water pumps, solar dryers, pest control, electric fences in livestock farms, solar tractors and other farm vehicles, solar greenhouses, solar cold storage, solar sensor and monitoring systems, solar irrigation controllers, solar grain mills, may be introduced. China, India, Kenya, Netherlands and the USA have adopted such technology resulting in boosting agriculture and livestock productivity.
11. The issue of payment to Independent Power Producers (IPPs) has been a permanent headache for the government, national exchequer and the common man. A serious dialogue may be initiated with the IPPs and a one time Golden HandShake must be made to get rid of these chronic issues.
12. Training accreditation and certification of service providers, installers, engineers, and technicians to ensure the quality of services and inputs to the clients of solar energy applications.
13. A Steering Committee on Solar Energy (SCSE) will be established at Sarhad Chamber of Commerce and Industries to: 1) oversee the issues faced by the stakeholders; 2) facilitate the outgoing university graduates to establish entrepreneurship models based upon their academic wisdom, in manufacturing and services in solar energy and; 3) to work on reducing the burden on public treasury through solarization of the state owned entities like universities, schools, colleges, offices, etc. The SCSE will be backed up by an Endowment Fund of Rs.5 billion and will comprise membership from:
    a. *4 Universities:* one member each from the UET Peshawar, UET Mardan, City University, and UoT Nowshera;
    b. *4 Companies:* one member each from and Tesla/Absol Energy, SunSaviour Pakistan, Barg Engineering Consultant, and SkyElectric;
    c. *2 Government Departments*: one member each from the Department of Industries and Higher Education and;
    d. *2 Civil Societies*: one representative each from Dairy Science Park, Pakistan Youth Organization;
    e. *2 SCCI*: two representatives of SCCI.

It will make the total membership of STSE as 14. The Committee members will be selected for a term of 3 years and the Chairman of the Committee will be elected by the members among themselves. The committee will make decisions on simple majority with a quorum of 50% of the total members.

Prof M Subhan Qureshi
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Panel Discussions

Titles

- Overcoming Barriers to Solar Energy Adoption
- Solar Energy Applications in KP
- Advancements in Solar Technology

Members

S No	Name	Title
1	Prof. Dr Subhan Qureshi	Dean (FAH and Vet Sci) Uni Agric, Peshawar President NESS Pak, Eco Security, ISN, Beijing President Dairy Sciences Park Chief Patron Green Wend Energy/SunSaviour
2	Prof. Dr Amanullah	Professor of Agronomy, Univ Agric Peshawar
3	Syed Asif Bacha	Vice Chairman Pakistan Youth Organization
4	Mr. Laiq Hassan	Chairman Computer System Engg, UET Peshawar
5	Engr Zeeshan Saeed Shah	CEO GreenWend Energy/SunSaviour/ISE2024
6	Saad Rasheed	CTO, Green Wend Energy
7	Syed Ashfaq	CEO, Al-Syed Solar Solution (Luky Marwat)
8	M. Ali	MD /CEO, Bridges Autism Center (Kohat)
9	Arshad Habib	Industrialist
10	M. Yasir	CEO, Pak Al Nasir Solar Energy
11	Asif Mehmood	MD, NEOM Engineering
12	M. Abdul Rehman	CEO, AR Brothers
13	Naseer Ahmed	Manager Shaobo Solar
14	Mr. Adnan Khan	UET Alumni/Director, Pakistan Railways Multan
15	Engr. M Saleem Barg	CEO BARG Engineering
16	Mian Abbas, MS Information Technology	Business Development Manager Green Wend Energy
17	Aemal Ahmad MSc Electrical Energy	Systems,USPCAS-E Peshawar Marketing Advisor, SunSaviour
18	Aaina Khan	Business Development Manager SunSaviour
19	Said Shah, BS Renewable Engineering	Senior Site Engineer
20	Engr. Izaz Ahmad Qureshi Master in Energy Systems, NUST	Operation Manager, GreenWend Energy Pvt Ltd.
21	Engr. Qasim Sattar MS Electrical Engineering, Ireland	CEO EnerTech Engineering Pvt Ltd
22	Waqas Ahmed	Assistant Professor UET Jalozai Campus

List of posters and Winners

S.NO	Name	University	Topic	Position
1	M. Zubair Afridi	Sarhad Univ of Science and IT	Smart Solar PV Cleaning Robot	1st Prize (50,000)
2	Urooj Khan	Khyber Medical College	Harnessing Solar Energy for Public Health: A Clean and Sustainable Solution	2nd Prize (30,000)
3	Ertiza Azhar Malik	UET Abbottabad	Realtime electrical energy monitoring and control system	3rd Prize (15,000)
4	Mudasir Aslam	Founder, Relife – Where innovations meet environment	Eco-Friendly Pencils	
5	Muhammad Ahmad	Electrical, Univ Technology Nowshera	Design and prototype of Portable charging Unit	
6	Jehanzeb	Electrical, UOT Nowshera	Roadside Battery charging Hybrid System	
7	Abu Talha	IT, UOT Nowshera	Automatic Solar tracking system	
8	Muneer Ahmad	Electrical, UOT Nowshera	Hybrid Power generation system	
9	Hasnat Ali Shah Muhammad Osama Mashal Arif	EE Dept, UET Mardan	IOT-Based 1KVA Metering Device for Server-Based Intermittent Billing.	
10	Salman Ali Khan, Muhammad Ali Khan, Awais Gohar	Electrical Power Engineering Department, UET Mardan	Modelling Of Gas Detecting Device For Providing Safety	
11	Waqas Sahar, Junaid Ahmad, Nabila Khan	Department of Electrical Engineering UET, Mardan	Solar-powered smart energy management with modified panels cleaning and sun tracking for UET Mardan	
12	M Haris, Bilal Ahmad, Hamza Saeed	; Department of Computer Science, UET Mardan	Digitization of Governor Secretariat KP	
13	Muhammad Umar Khan	6 th Semester EE, UET Peshawar (Jalozai Campus)	Conversion Kit for E-bike	
14	Muhamamd Mazhar	Renewable Energy, UOT, Nowshera	A Review of Solar Photovoltaic Technologies	
15	Mudassir Aslam	Relife.pk	ECO FRIENDLY PENCILS	
16	Aliza Inam	Solar Thermal System, NED University, Karachi	Building as a combination of energy systems	

S.NO	Name	University	Topic	Position
17	Muhammad Waris Waqas Ahmad Ikramullah	UET Peshawar, Jalozai Campus	Design and fabrication of portable solar refrigerator using thermoelectric effect	
18	Huzaifa Yousaf Usman Yousaf	EE, UET Peshawar	Thermoelectric cooling based portable vaccine carrying module	
19	Bilal Ahmad Junaid Khan Khushal Khan	UET Peshawar, Jalozai Campus	Performance enhancement of photovoltaic cell using thermoelectric cooling	
20	Shaheed Shaida Durrani, Muhammad Yamin, Muhammad Hamza Azman	City Univ	Design and implemntation of solar charging station for electric vehicles (EVs)	

List of Companies with Winning Status

S No	Name	Position	Name of Company
1	Abdullah	CEO	Absol/Tesla Pakistan (First Position)
2	Abdul Wahid Khan	CEO	MD Electrical & Solar/FOX (Second Position)
3	Shahid Sultan	Official distributor	Ziewinic Solar (Third Position)
4	M. Yasir	CEO	Pak Al-Nasir Solar Energy
5	Asif Mehmood	MD	NEOM Engineering
6	M. Abdul Rehman	CEO	AR Brothers
7	Naseer Ahmed	Manager	Shaobo Solar
8	Sheikh Shiraz Saleem	CEO	American Solar
9	Ibrar Yousafzai	CEO	Voltmines Pvt. Ltd.
10	Raheem Ullah Khan	CEO	Solarise
11	Ashfaq	CEO	Al-Syed Solar Solutions
12	Imran Shafiq	CEO	Solar Asia
13	Ch. Nouman Aslam	CEO	Silk Cables
14	M. Rashid Maqbool	CEO	D-Tech Solar Energy
15	Owais Qarni	Zonal Head KPK, North	Copper GAT CABLES
16	M. Bilal Afsar	CEO	Invincible Energy
17	Shiraz & Brothers	CEO	FIAA Motorcycle Spare Parts whole sale Dealer
18	Qazi Kamran Amin	CEO	Solar I-Con
19	Zeeshan Saeed Shah	CEO	GreenWend Energy

International Solar Expo and Conference (ISE)

Floor 3, Khyber Heights, University Road, Peshawar.
Tel. 0315 9006826; https://internationalsolarexpo.com/

The Academia-Industry Advisory Board - ISE

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3. Prof. Dr. Amjadullah Khattak, Chairman EE, UET, Peshawar
4. Prof Amanullah Khan, Agronomy Department, UA Peshawar
5. Dr Haider Ali, HOD EET, UOT, Nowshera
6. Dr Adnan Daud, HOD Renewable Energy Engineering, USPCASE, UET, Peshawar
7. Dr Amjad Ali, HOD EE, Jalozai Campus, UET, Peshawar
8. Dr Tariq Sadad, Director ORIC, UET, Mardan
9. Mr Sohail Anjum, Secretary Sarhad Chamber of Commerce and Industries, Peshawar
10. Engr Zeeshan Saeed Shah, Chief Executive Officer, ISE
11. Engr Samia Subhan Qureshi, Director SunSaviour
12. Engr Saad Rashid, Chief Technical Officer, GWE
13. Engr Irfan ul Haq Qureshi, Coordinator General, ISE

Terms of Reference:

1. Promoting linkages among the academia and industry with special focus on facilitating the outgoing university graduates in developing entrepreneurship models.
2. Identification and response to the issues faced by stakeholders of the solar industry.
3. Recommendations to the policy makers on policy matters related to solar energy.

Signed

(Engr Irfan ul Haq Qureshi)
Coordinator General ISE
25 June, 2024

The Organizing Team of ISE2024

 Prof M Subhan Qureshi	 Engr Zeeshan S Shah	 Engr Samia S Qureshi	 Engr Saad Rashid
 Engr Irfan Ul Haq	 Engr Hamna Raziq	 Mamoon Saeed Shah	 Ayesha Khan
 Saleem Khan	 Alia Siddiqui	 Aaina Khan	 Jaseem Akhtar
 Engr Aemal Ahmad	 Mr Farooq Yousafzai	 Hazrat Usman	 Abubakar Younus khan

The Event in Pictures

Inviting Vice Chancellor and his Team at City University Peshawar

Inviting UET Peshawar

Inviting SCCI Peshawar

Inviting RCCI, Rawalpindi

Inviting KPEZDMC

Visiting SEZ Rashakai

Inviting Syed Sardar Badshah, President Pak Youth Org

GreenWendEnergy
Think Solar To Live Better

Inviting Adv Arif Yousaf GoKP and Ashfaq Paracha Pakistan Business Forum

Inviting Rizwan Medical Center

Inviting Univ Agric Peshawar

Inviting USPCASE

Inviting CECOS

Inviting UET and AWKUM Mardan

Inviting UET-Campus Jalozai

Inviting Governor Gilgit Baltistan

Inviting IM Sciences

Haji Ghulam Ali, Ex Governor KP inaugurated ISE2024

Chief Guest with Organizers of ISE2024

The Participants

Mr Fuad Ishaq, President SCCI chaired the Concluding Session of ISE2024

Chief Guest briefed on E-Bikes stall

Fox ESS presents a gift to Mr Ijaz Khan Afridi, Vice President SCCI

Manha and Zaland with the Chief Guest

Attending the Panel Discussion

Gift presented to the Chief Guest

Celebrating the Milestone